PATENT ABSTRACTS OF JAPAN

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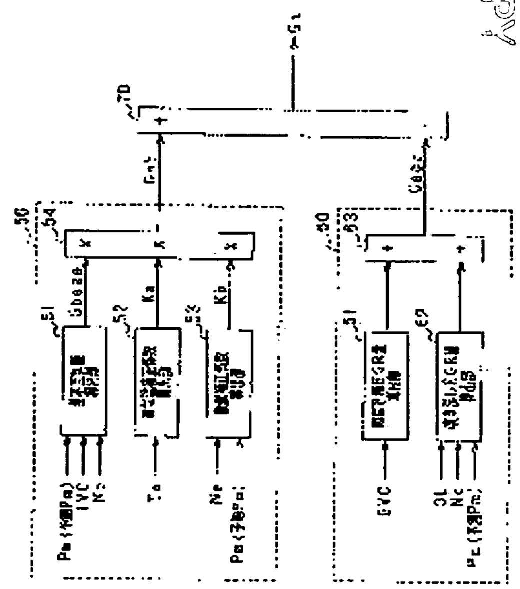
(71)Applicant : DENSO CORP
(72)Inventor : TANAKA MAKOTO
OBAYASHI HIDEKI

(54) AIR AMOUNT CALCULATION DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To accurately calculate an in-cylinder filled air amount while simplifying operation logic.
SOLUTION: A basic filled air amount calculation part 50 calculates a basic air amount Gbase, an intake temperature correction factor Ka and a pulsation correction factor Kb, respectively, thereby acquiring a basic filled air amount Gnb. An internal EGR amount calculation part 60 calculates a clearance volume EGR amount on the basis of exhaust valve closing timing EVC, a valve overlap amount OL, a blowback EGR amount on the basis of an engine rotation speed Ne and an intake pipe pressure Pm, and an internal EGR amount Gegr by adding the clearance volume EGR amount and the blowback EGR amount. An in-cylinder filled air amount calculation part 70 calculates the in-cylinder filled air amount Gn by subtracting the internal EGR amount Gegr from the basic filled air amount Gnb.



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CLAIMS

[Claim(s)]
[Claim 1]
In the restoration air content calculation equipment in a cylinder of the internal combustion engine having the adjustable valve train means which makes adjustable one [at least] closing motion stage or amount of lifts of an intake valve and an exhaust air bulb,
A basic air content calculation means to compute a basic air content based on an internal combustion engine's operating range,
An amount calculation means of internals EGR to compute the capacity of the internal EGR generated by the closing motion stage of the intake valve by said good fluctuation valve means, or an exhaust air bulb etc.,
A restoration air content calculation means in a cylinder to compute said restoration air content in a cylinder with said basic air content and amount of internals EGR,
Air content calculation equipment of the internal combustion engine characterized by preparation ******.
[Claim 2]
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 1 which computes the amount of internals EGR based on the amount of valve-opening overlap of the pressure-of-induction-pipe force, an engine engine speed, the close stage of an exhaust air bulb, an intake valve, and an exhaust air bulb.
[Claim 3]
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 2 which computes the amount of internals EGR by applying the exhaust gas pressure in an internal combustion engine's flueway as a parameter.
[Claim 4]
The compressor formed in the inhalation-of-air path is connected with the turbine prepared in the flueway, and it has the supercharger which supercharges the inhalation of air supplied to an internal combustion engine by operating a turbine, and is applied to the internal combustion engine which prepared the waist gate valve which bypasses said flueway and adjusts charge pressure,
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 2 which computes the amount of internals EGR by adding the opening of said waist gate valve as a parameter.
[Claim 5]
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 1 which computes the amount of internals EGR by having a means to compute the 1st capacity which is the amount of burned gas which remains in a cylinder after combustion, and a means to compute the 2nd capacity which is the amount of burned gas blown back at an inhalation-of-air path side, and adding these 1st capacity and the 2nd capacity.
[Claim 6]
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 5 which computes said 1st capacity based on the close stage of an exhaust air bulb at least.
[Claim 7]
Said amount calculation means of internals EGR is air content calculation equipment of the internal combustion engine according to claim 5 or 6 which computes said 2nd capacity based on the amount of valve-opening overlap of an intake valve and an exhaust air bulb at least.

[Claim 8]
Said amount calculation means of internals EGR is air content calculation equipment of an internal combustion engine given in claim 5 thru/or any of 7 they are. [which computes at least one side of said 1st capacity and said 2nd capacity by applying the exhaust gas pressure in an internal combustion engine's flueway as a parameter]
[Claim 9]
The compressor formed in the inhalation-of-air path is connected with the turbine prepared in the flueway, and it has the supercharger which supercharges the inhalation of air supplied to an internal combustion engine by operating a turbine, and is applied to the internal combustion engine which prepared the waist gate valve which bypasses said flueway and adjusts charge pressure,
Said amount calculation means of internals EGR is air content calculation equipment of an internal combustion engine given in claim 5 thru/or any of 7 they are. [which computes at least one side of said 1st capacity and said 2nd capacity by adding the opening of said waist gate valve as a parameter]
[Claim 10]
It is air content calculation equipment of an internal combustion engine given in claim 1 thru/or any of 9 have a means to predict change of a future bulb closing motion stage etc., and said amount calculation means of internals EGR is. [which computes the amount of internals EGR based on said bulb closing motion stage of the predicted future etc.]
[Claim 11]
It is air content calculation equipment of an internal combustion engine given in claim 1 thru/or any of 10 have a means to predict an internal combustion engine's future load, and said basic air content calculation means is. [which computes a basic air content, using said load of the predicted future as a parameter]
[Claim 12]
Said basic air content calculation means is air content calculation equipment of an internal combustion engine given in claim 1 thru/or any of 11 they are. [which computes a basic air content based on the close stage of an internal combustion engine's engine speed, a load, and an intake valve]
[Claim 13]
Air content calculation equipment of an internal combustion engine given in claim 1 thru/or any of 12 they are. [which was further equipped with a means to amend said basic air content so that the effect of the inhalation-of-air pulsation produced in the engine operational status which becomes more than a predetermined load corresponding to an engine rotational frequency may be canceled]
[Claim 14]
Air content calculation equipment of an internal combustion engine given in claim 1 thru/or any of 13 they are. [which was further equipped with a means to amend said basic air content according to the temperature of the air inhaled from said inhalation-of-air path]

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
This invention relates to the air content calculation equipment of the internal combustion engine for computing the restoration air content in a cylinder with which it fills up in the cylinder of the internal combustion engine concerned with a sufficient precision in the internal combustion engine having an adjustable valve train means.
[Background of the Invention]
[0002]
The restoration air content in a cylinder with which it fills up in an internal combustion engine's cylinder is computed, and there is a technique which controls fuel oil consumption and ignition timing based on the restoration air content in a cylinder. In this case, the restoration air content in a cylinder is actually shut up in a cylinder, and since it is the air content which participates in combustion within a cylinder, high-degree-of-accuracy-ization of control of fuel oil consumption or ignition timing is attained by using this restoration air content in a cylinder as a parameter. There are some which are computed as the calculation technique of the restoration air content in a cylinder based on an engine rotational frequency and the pressure-of-induction-pipe force.
[0003]
By the way, in recent years, many internal combustion engines having an adjustable valve train means are put in practical use, the closing motion stage of an intake valve or an exhaust air bulb etc. is adjusted by the adjustable valve train means, and the output, the improvement of fuel consumption, etc. are achieved. Moreover, the so-called internal EGR occurs by adjusting the closing motion stage of an intake valve or an exhaust air bulb etc. in this case. In the internal combustion engine having this adjustable valve train means, even if the pressure-of-induction-pipe force is the same, the condition of internal EGR changes a lot by a bulb closing motion stage etc. being changed, and the problem that the restoration air content in a cylinder cannot compute to accuracy arises. Moreover, although suiting in all combination is also considered about each parameter, such as an engine operating range and a bulb closing motion stage, that the effect of internal EGR should be reflected, now, the problem that adaptation manday and a data-processing load increase will be caused.
[0004]
In addition, the technique of the patent reference 1 is known as air content detection equipment of the internal combustion engine having an adjustable valve train means. By this patent reference 1, in ignition-timing control, an air flow meter detects an inhalation air content, and the inhalation air content in the average value of the inhalation air content in an intake valve open stage and an intake valve close stage or the midpoint of an intake valve open period is made into the restoration air content in a cylinder. And it was considering as the configuration which calculates ignition timing by this restoration air content in a cylinder. However, with this configuration, the restoration air content in a cylinder is fundamentally calculated from the detection result of an air flow meter, ignition-timing control is carried out based on the restoration air content in a cylinder, and the problem that a restoration air content is uncomputable to a transient at accuracy arises according to the detection delay of an air flow meter, or the inlet-pipe passage delay of inhalation air.
[Patent reference 1] JP,9-303242,A
[Description of the Invention]
[Problem(s) to be Solved by the Invention]

[0005]
This invention sets it as the main object to offer the air content calculation equipment of the internal combustion engine which can compute the restoration air content in a cylinder with a sufficient precision, attaining simplification of operation logic.
[Means for Solving the Problem]
[0006]
In the internal combustion engine having an adjustable valve train means, by making a factor a change of the closing motion stage of an intake valve or an exhaust air bulb, or the amount of lifts, the amount of internals EGR changes a lot, and the amount (restoration air content in a cylinder) of the new mind with which it fills up in a cylinder by that cause changes. Here, in invention according to claim 1, while a basic air content is computed based on an internal combustion engine's operating range, the capacity (the amount of internals EGR) of the internal EGR generated by the closing motion stage of the intake valve by the adjustable valve train means or an exhaust air bulb etc. is computed, and the restoration air content in a cylinder is further computed by a basic air content and the amount of internals EGR. In this case, the restoration air content in a cylinder can compute with a sufficient precision also at the time of generating of the internal EGR accompanying modification of the closing motion stage of an intake valve or an exhaust air bulb etc. by computing a basic air content and the amount of internals EGR according to an individual. Moreover, in order to have calculated the restoration air content in a cylinder with a sufficient precision in the existing technique, the closing motion stage of an intake valve or an exhaust air bulb etc. needed to be added as a parameter in addition to operating-range parameters, such as an engine engine speed and a load, it needed to suit beforehand in the combination of all parameters, and problems, such as buildup of adaptation manday and an increment in a data-processing load, had arisen. On the other hand, in this invention, it can write computing the amount of internals EGR separately, and the combination of the part adaptation can be reduced. The restoration air content in a cylinder is computable with a sufficient precision with the above, attaining simplification of operation logic. In addition, it is good to compute the restoration air content in a cylinder by subtracting the amount of internals EGR from a basic air content simply.
[0007]
In invention according to claim 2, the amount of internals EGR is computed based on the amount of valve-opening overlap of the pressure-of-induction-pipe force, an engine engine speed, the close stage of an exhaust air bulb, an intake valve, and an exhaust air bulb. In this case, since the amount of internals EGR changes with the amounts of valve-opening overlap of the pressure-of-induction-pipe force, an engine engine speed, the close stage of an exhaust air bulb, an intake valve, and an exhaust air bulb, a parameter, then the amount of internals EGR are [these] computable to accuracy.
[0008]
In invention according to claim 3, the amount of internals EGR is computed by applying the exhaust gas pressure in an internal combustion engine's flueway as a parameter. If exhaust gas pressure changes, the amount of internals EGR will change. In this case, a parameter, then the amount of internals EGR can compute exhaust gas pressure to accuracy more. Therefore, the restoration air content in a cylinder is computable with a sufficient precision also at the time of change of exhaust gas pressure.
[0009]
In invention according to claim 4, the amount of internals EGR is computed by adding the opening of a waist gate valve as a parameter in the internal combustion engine which prepared the waist gate valve for charge pressure adjustment. Since exhaust gas pressure will change if the opening of a waist gate valve changes, the amount of internals EGR changes. In this case, a parameter, then the amount of internals EGR can compute the opening of a waist gate valve to accuracy more. Therefore, the restoration air content in a cylinder is computable with a sufficient precision also at the time of opening modification of a waist gate valve.
[0010]
Moreover, in invention according to claim 5, while the 1st capacity which is the amount of burned gas which remains in a cylinder after combustion is computed, the 2nd capacity which is the amount of burned gas blown back at an inhalation-of-air path side is computed, and the amount of internals EGR is computed by addition with these 1st capacity and the 2nd capacity. In this case, according to the generating factor of internal EGR, the amount of internals EGR can be computed now to accuracy, as a result the calculation precision of the restoration air content in a cylinder improves. For example, internal-EGR capacity can be simply computed now by preparing respectively the map for the 1st capacity calculation, and the map for the 2nd capacity calculation.

[0011]
Here, the 1st capacity is the amount of burned gas which remained without being discharged at a flueway side, when an exhaust air bulb closes, and it depends for it on cylinder content volume (this is also called clearance volume) in case an exhaust air bulb closes fundamentally. Therefore, as indicated to claim 6, it is good to compute the 1st capacity based on the close stage of an exhaust air bulb at least. Specifically, it is computed so that the close stage of an exhaust air bulb separates from inhalation of air TDC, and the 1st capacity may become large.
[0012]
Moreover, the 2nd capacity is [both] the amount of burned gas blown back during the overlap period which the intake valve and the exhaust air bulb are opening at an inhalation-of-air path side, and it depends for it on the amount of valve-opening overlap of said both bulbs fundamentally. Therefore, as indicated to claim 7, it is good to compute the 2nd capacity based on the amount of valve-opening overlap of an intake valve and an exhaust air bulb at least. Specifically, it is computed so that the amount of overlap is large, and the 2nd capacity may become large. In addition, it is also possible to consider as the configuration which computes the 2nd capacity by applying an engine rotational frequency and inhalation-of-air path internal pressure as a parameter in addition to the amount of overlap.
[0013]
In invention according to claim 8, at least one side of said 1st capacity and said 2nd capacity is computed by applying the exhaust gas pressure in an internal combustion engine's flueway as a parameter. If exhaust gas pressure changes, the amount of burned gas which remains in a cylinder, or the amount of burned gas blown back at an inhalation-of-air path side will change. A parameter then the 1st capacity, and the 2nd capacity can compute exhaust gas pressure to accuracy more, and, as a result, the calculation precision of the amount of internals EGR improves. Therefore, the restoration air content in a cylinder is computable with a sufficient precision also at the time of change of exhaust gas pressure.
[0014]
In invention according to claim 9, at least one side of said 1st capacity and said 2nd capacity is computed by adding the opening of a waist gate valve as a parameter in the internal combustion engine which prepared the waist gate valve for charge pressure adjustment. Since exhaust gas pressure will change if the opening of a waist gate valve changes, the amount of burned gas which remains in a cylinder, or the amount of burned gas blown back at an inhalation-of-air path side changes. A parameter then the 1st capacity, and the 2nd capacity can compute the opening of a waist gate valve to accuracy more, and, as a result, the calculation precision of the amount of internals EGR improves. Therefore, the restoration air content in a cylinder is computable with a sufficient precision also at the time of opening modification of a waist gate valve.
[0015]
In invention according to claim 10, change of a future bulb closing motion stage etc. is predicted, and the amount of internals EGR is computed based on the this predicted future bulb closing motion stage. In this case, since the amount of internals EGR is computed reflecting change of a future bulb closing motion stage etc., it becomes possible to compute the restoration air content in a cylinder with a sufficient precision to the transient to which a service condition changes suddenly.
[0016]
In invention according to claim 11, an internal combustion engine's future load is predicted and a basic air content is computed by making the this predicted future load into a parameter. In this case, since a basic air content is computed reflecting a future change of load, it becomes possible to compute the restoration air content in a cylinder with a sufficient precision to the transient to which a service condition changes suddenly.
[0017]
In invention according to claim 12, a basic air content is computed based on the close stage of an internal combustion engine's engine speed, a load, and an intake valve. In this case, the air content with which a cylinder is fed from an inhalation-of-air system is decided with an engine engine speed or a load, and it is decided with which of the air with which it is fed by the close stage of an intake valve it will fill up in a cylinder. With the configuration which computes a basic air content by making the close stage of an engine engine speed, a load, and an intake valve into a parameter, the basic air content concerned can compute with a sufficient precision.
[0018]
In invention according to claim 13, said basic air content is amended so that the effect of the inhalation-of-air pulsation produced in the engine operational status which becomes more than a predetermined load

corresponding to an engine rotational frequency may be canceled. By an internal combustion engine's loaded condition in low, a basic air content is proportional to a load in general, and is changed in response to the effect of inhalation-of-air pulsation in the heavy load condition (for example, WOT condition). Since it generates in a specific engine revolution region, this inhalation-of-air pulsation is good to define the amount of amendments according to an engine rotational frequency, and for that amount of amendments to amend a basic air content. Thereby, the effect of inhalation-of-air pulsation is canceled, and the calculation precision of the restoration air content in a cylinder improves.

[0019]

In invention according to claim 14, said basic air content is amended according to the temperature of the air inhaled from said inhalation-of-air path. Change of the temperature of inhalation air changes a basic air content by consistency change. By amending a basic air content according to the temperature of inhalation air, the calculation precision of the restoration air content in a cylinder improves.

[Best Mode of Carrying Out the Invention]

[0020]

Hereafter, the gestalt of the 1 operation which materialized this invention is explained according to a drawing. Suppose the gestalt of this operation that the engine control system shall be built for the Taki cylinder four stroke cycle engine for mount which is an internal combustion engine, and control of fuel oil consumption, control of ignition timing, etc. are carried out by using an electronic control unit (henceforth ECU) as a center in the control system concerned. First of all, the whole engine control system outline block diagram is explained using drawing 1 .

[0021]

In the engine 10 shown in drawing 1 , an air cleaner 12 is formed in the maximum upstream section of an inlet pipe 11, and the air flow meter 13 for detecting an inhalation air content is formed in the downstream of this air cleaner 12. The throttle valve 14 by which opening accommodation is carried out with actuators, such as a DC motor, and the throttle opening sensor 15 for detecting a throttle opening are formed in the downstream of an air flow meter 13. A surge tank 16 is formed in the downstream of a throttle valve 14, and the pressure-of-induction-pipe force sensor 17 for detecting the pressure-of-induction-pipe force is formed in this surge tank 16. moreover, the electromagnetism which the inlet manifold 18 which introduces air into each cylinder of an engine 10 is connected to the surge tank 16, and carries out injection supply of the fuel near the inlet port of each cylinder in an inlet manifold 18 -- the fuel injection valve 19 of an actuation type is attached.

[0022]

The intake valve 21 and the exhaust air bulb 22 are formed in the inlet port and exhaust port of an engine 10, respectively, the gaseous mixture of air and a fuel is introduced by open actuation of an intake valve 21 in a combustion chamber 23, and the exhaust gas after combustion is discharged by the exhaust pipe 24 by open actuation of the exhaust air bulb 22. The adjustable valve gears 25 and 26 are formed in the intake valve 21 and the exhaust air bulb 22, respectively. These adjustable valve gears 25 and 26 have the structure which can make adjustable continuously closing motion timing of each bulbs 21 and 22, and bulb closing motion timing is suitably adjusted according to an accelerator opening, an engine operation condition, etc. of each time.

[0023]

The ignition plug 27 is attached in the cylinder head of an engine 10 for every cylinder, and high tension is impressed to an ignition plug 27 in ignition timing considered as a request through the ignition 28 which consists of an ignition coil etc. The gaseous mixture which spark discharge generated between the counterelectrodes of each point fire plug 27, and was introduced in the combustion chamber 23 by impression of this high tension is lit, and combustion is presented.

[0024]

The catalysts 31, such as a three way component catalyst for purifying CO, HC, NOx, etc. in emission gas, are formed in an exhaust pipe 24, and the air-fuel ratio sensors 32 for detecting the air-fuel ratio of gaseous mixture, or rich/Lean by making exhaust gas applicable to detection at the upstream of this catalyst 31 (a linear air-fuel ratio sensor, oxygen sensor, etc.) are formed in it. Moreover, the cooling coolant temperature sensor 33 which detects cooling water temperature, and the crank angle sensor 34 which outputs a rectangle-like crank angle signal for every predetermined crank angle of an engine 10 (with for example, 10-degreeCA period) are attached in the cylinder block of an engine 10. In addition, the intake temperature sensor 35 which detects the temperature of inhalation air, and the accelerator sensor 36 which detects the amount of treading in of an accelerator pedal (accelerator opening) are formed.

[0025]
The output of the various sensors mentioned above is inputted into ECU40 which manages engine control. ECU40 is constituted considering the microcomputer which consists of CPU, a ROM, RAM, etc. as a subject, is performing various kinds of control programs memorized by ROM, and controls the closing motion timing of the fuel injection by the fuel injection valve 19, ignition timing by the ignition plug 27, the intake valve 21 by the adjustable valve gears 25 and 26, and the exhaust air bulb 22 etc. based on an engine operation condition.
[0026]
Lift actuation of an intake valve 21 and the exhaust air bulb 22 is shown in drawing 2 , and, for an exhaust air bulb open stage and EVC, an exhaust air bulb close stage and IVO are [EVO / an intake valve close stage and OL of an intake valve open stage and IVC] the amounts of valves overlap in this drawing 2 . The closing motion stage of each bulbs 21 and 22 is adjusted by the adjustable valve gears 25 and 26, and an exhaust air bulb closing motion stage is controlled for an intake valve closing motion stage on the basis of the maximum tooth-lead-angle location on the basis of the maximum angle-of-delay location at an angle-of-delay side at a tooth-lead-angle side, respectively. At this time, the valve overlap from which each bulb of both will be in an open condition arises by the tooth-lead-angle control by the side of an intake valve, and angle-of-delay control by the side of an exhaust air bulb. In addition, with the gestalt of this operation, an intake valve 21 is set to 40-degreeCA after the IVO= inhalation of air TDC in the state of the maximum angle of delay, and is considered as the configuration which can carry out a maximum of 60-degreeCA tooth lead angle from the maximum angle-of-delay location. Moreover, the exhaust air bulb 22 is set to 4-degreeCA before the EVC= inhalation of air TDC in the state of the maximum tooth lead angle, and is considered as the configuration which can carry out a maximum of 60-degreeCA angle of delay from the maximum tooth-lead-angle location.
[0027]
Here, if the exhaust air bulb 22 is controlled at an angle-of-delay side or the amount of valves overlap becomes large, internal EGR will increase. With the gestalt of this operation, it supposes that it divides into a part for a part for EGR which makes a factor angle-of-delay-ization of an exhaust air bulb close stage for internal EGR, and EGR which makes a valve overlap a factor, and thinks, and drawing 3 explains the mechanism.
[0028]
In (a) of drawing 3 , the exhaust air bulb close stage EVC has become the TDC back (however, there shall be no valve overlap). In this case, it passes over TDC, and since the exhaust air bulb 22 is open also after a piston starts to descend from lifting, burned gas flows in a cylinder (inside of a combustion chamber 23) from an exhaust port. Thereby, burned gas remains in a cylinder after closeout of the exhaust air bulb 22, and internal EGR occurs. Being decided depending on a part for the cylinder content volume which set by the time the exhaust air bulb 22 closed the amount of internals EGR by the residual gas in a cylinder, and was extended by descent of a piston is checked by the invention-in-this-application person. Hereafter, this amount of internals EGR is called "amount of clearance-volume EGR(s)." At this time, the cylinder content volume in the exhaust air bulb close stage EVC is a clearance volume, and the amount of clearance-volume EGR(s) can be computed according to the exhaust air bulb close stage EVC.
[0029]
Moreover, the valve overlap has arisen in (b) of drawing 3 . In this case, burned gas is blown back by the inspired air flow path in order that an intake valve 21 and the exhaust air bulb 22 may open simultaneously. Thereby, in a consecutive intake stroke, burned gas re-flows in a cylinder, and internal EGR occurs. It is checked by the invention-in-this-application person that the amount of internals EGR depended for blowing back is decided depending on the amount of valves overlap. the amount of the following and this internal EGR -- "-- it blows back and is called amount of EGR(s)." At this time, it blows back according to the amount of valves overlap, and the amount of EGR(s) can be computed.
[0030]
If the amount of internals EGR increases, the air content (restoration air content in a cylinder) with which it fills up in a cylinder according to the amount of EGR(s) will decrease. this -- it clearance-volume-EGR(s) at the time, and blows back, and reduction of the restoration air content in a cylinder arises by EGR, and first, about a clearance volume EGR, the amount of clearance-volume EGR(s) increases, so that the exhaust air bulb close stage EVC shifts to an angle-of-delay side on the basis of inhalation of air TDC, as shown in drawing 4 , and the restoration air content in a cylinder decreases in connection with it. Moreover, it blows back, the amount of EGR(s) increases and the restoration air content in a cylinder decreases in connection

with it, so that the amount OL of valves overlap becomes large, as it blows back and EGR is shown in drawing 5 .
[0031]
In order to raise the control precision of fuel-oil-consumption control or ignition-timing control, when an intake valve 21 closes, it requires grasping the amount (restoration air content Gn in a cylinder) of the new mind with which it fills up in an engine cylinder actually with a sufficient precision. So, suppose that improvement in calculation precision of the restoration air content in a cylinder is aimed at with the gestalt of this operation by amending the decrement of the restoration air content in a cylinder by said internal EGR. In addition, improvement in calculation precision of the further restoration air content in a cylinder is aimed at by performing inhalation-of-air pulsating amendment, an intake temperature correction, etc.
[0032]
The restoration air content Gn in a cylinder is computed as the operation parameter at the time of the operation of fuel oil consumption, and it is computed by taking a future transient change etc. into consideration actually. It is specifically considering as the configuration which computes the restoration air content Gn in a cylinder based on the pressure-of-induction-pipe force Pm, the future pressure-of-induction-pipe force Pm is predicted, and the restoration air content Gn in a cylinder is computed using the prediction Pm. In addition, the thing using the throttle delay model as a forecasting method of the pressure-of-induction-pipe force Pm can be applied, for example, a future throttle opening is predicted from the accelerator opening operated by the operator, and the future pressure-of-induction-pipe force Pm is predicted based on the prediction throttle opening.
[0033]
Drawing 6 is the functional block diagram of ECU40 about the operation of the restoration air content in a cylinder. Here, the pressure-of-induction-pipe force Pm of using for the operation of the restoration air content Gn in a cylinder is all the above-mentioned prediction Pm, and each parameters, such as engine-speed Ne and an intake-air temperature Ta, are the values based on the detection result of various sensors.
[0034]
In drawing 6 , the basic restoration air content calculation section 50 and the amount calculation section 60 of internals EGR are formed as main configurations, the basic restoration air content Gnb is computed in the basic restoration air content calculation section 50, and the amount Gegr of internals EGR is computed in the amount calculation section 60 of internals EGR. First of all, the basic restoration air content calculation section 50 is explained in detail. In the basic restoration air content calculation section 50, the basic air content calculation section 51 computes the basic air content Gbase based on the pressure-of-induction-pipe force Pm, the intake valve close stage IVC, and an engine speed Ne. The basic air content Gbase is computed by making Pm, IVC, and Ne of that each time into a parameter using the basic air content map shown at this time, for example, drawing 7 . On the basic air content map of drawing 7 , relation to which the basic air content Gbase under the conditions from which the amount of internals EGR serves as min is computed, and the basic air content Gbase becomes large for every engine speed, so that the pressure-of-induction-pipe force Pm is large in general, or, so that the intake valve close stage IVC is a tooth-lead-angle side is defined.
[0035]
The intake temperature correction multiplier calculation section 52 computes the intake temperature correction multiplier Ka based on the intake-air temperature Ta of each time. At this time, it is [that it should correspond to change of the air density by the intake-air temperature Ta] so good that an intake-air temperature Ta is high to make the intake temperature correction multiplier Ka into a small value.
[0036]
The pulsating correction factor calculation section 53 computes the pulsating correction factor Kb based on an engine speed Ne and the pressure-of-induction-pipe force Pm. This is for controlling dispersion in the restoration air content by the inhalation-of-air pulsation generated within an inlet pipe, and computes the pulsating correction factor Kb based on the relation shown in drawing 8 as an example. However, since it mainly generates in the state of a heavy load (for example, WOT condition), inhalation-of-air pulsation is good to compute the pulsating correction factor Kb only within predetermined heavy load operational status.

[0037]
The basic air content amendment section 54 computes the basic restoration air content Gnb by multiplying the intake temperature correction multiplier Ka and the pulsating correction factor Kb by the basic air content Gbase (Gnb=GbasexKaxKb).

[0038]
Moreover, in the amount calculation section 60 of internals EGR, the amount calculation section 61 of clearance-volume EGR(s) computes the amount of clearance-volume EGR(s) based on the exhaust air bulb close stage EVC. At this time, the relation between the exhaust air bulb close stage EVC and the amount of clearance-volume EGR(s) is as above-mentioned drawing 4 , and computes the amount of clearance-volume EGR(s) using the clearance-volume EGR map created based on the relation of this drawing 4 . In addition, the exhaust air bulb close stage EVC is a control forecast by which the exhaust air bulb 22 is controlled in the future.
[0039]
It blows back, and the amount calculation section 62 of EGR(s) is blown back based on the amount OL of valves overlap, an engine speed Ne, and the pressure-of-induction-pipe force Pm, and computes the amount of EGR(s). At this time, it blows back with the amount of valves overlap, and it is as above-mentioned drawing 5 , and the relation with the amount of EGR(s) is created and blown back based on the relation of this drawing 5 , is blown back using an EGR map, and computes the amount of EGR(s). Moreover, it is good to blow back, since the time amount of return [blow] is shortened when an engine speed Ne is high, to blow back, since it lessens, and the degree of return [blow] increases the amount of EGR(s) when the pressure-of-induction-pipe force Pm is small (negative pressure is large), and to enlarge the amount of EGR (s). In addition, the amount OL of valves overlap is a control forecast by which each bulbs 21 and 22 are controlled in the future. It is also possible to replace with the pressure-of-induction-pipe force Pm, and to make differential pressure of the pressure-of-induction-pipe force and exhaust gas pressure into a parameter.

[0040]
And it computes the amount Gegr of internals EGR by the amount calculation section 63 of internals EGR blowing back with the amount of clearance-volume EGR(s), and adding the amount of EGR(s). Furthermore, the restoration air content calculation section 70 in a cylinder computes the restoration air content Gn in a cylinder by subtracting the amount Gegr of internals EGR from the basic restoration air content Gnb. In this way, by the computed restoration air content Gn in a cylinder, the operation of fuel oil consumption, the operation of ignition timing, etc. are performed, and fuel-injection control and ignition-timing control are carried out based on those results of an operation.
[0041]
According to the gestalt of this operation explained in full detail above, the effectiveness which was excellent in the following is acquired.
[0042]
Since the basic restoration air content Gnb and the amount Gegr of internals EGR are computed according to an individual and the restoration air content Gn in a cylinder was computed by these [Gnb] and Gegr on the occasion of calculation of the restoration air content Gn in a cylinder, the restoration air content Gn in a cylinder is computable with a sufficient precision reflecting the amount of internals EGR. While computing the basic air content Gbase using the basic air content map as basic air content adaptation data at this time, it writes as the clearance-volume EGR map and the configuration which blows back and computes the amount of internals EGR using an EGR map as amount adaptation data of internals EGR, the combination of adaptation decreases, and complicated adaptation becomes unnecessary. Moreover, cutback-ization of each map data also becomes possible (growing gigantic of map data can be controlled). By the above, the restoration air content Gn in a cylinder can be computed with a sufficient precision, attaining simplification of operation logic. It also becomes possible to raise fuel oil consumption and the control precision of ignition timing because the calculation precision of the restoration air content Gn in a cylinder goes up.
[0043]
Moreover, it writes as the configuration which blows back with the amount of clearance-volume EGR(s) (the 1st capacity), and computes the amount of internals EGR by addition with the amount of EGR(s) (the 2nd capacity), and the amount of internals EGR can be computed to accuracy according to the generating factor of internal EGR, as a result the calculation precision of the restoration air content Gn in a cylinder improves.
[0044]
It writes as the amount of clearance-volume EGR(s), and the configuration blow back and using a future control forecast (the exhaust air bulb close stage EVC, the amount OL of valves overlap) as a parameter on the occasion of calculation of the amount of EGR(s), and it becomes possible to compute the amount of internals EGR with a sufficient precision to the transient to which a service condition changes suddenly.

[0045]
Moreover, on the occasion of calculation of the basic restoration air content Gnb, it writes as the configuration using the forecast (prediction Pm) of the pressure-of-induction-pipe force Pm which counted upon a future change as a parameter, and it becomes possible to compute the basic restoration air content Gnb with a sufficient precision to the transient to which a service condition changes suddenly.
[0046]
The basic restoration air content Gnb is total capacity (new mind + burned gas) shut up in a cylinder in an intake valve close stage, and accuracy is asked by making engine-speed Ne, the pressure-of-induction-pipe force Pm, and an intake valve close stage into a parameter. Moreover, since the basic restoration air content Gnb was computed by performing inhalation-of-air pulsating amendment and an intake temperature correction, the calculation precision of the restoration air content Gn in a cylinder improves dramatically.
[0047]
In addition, this invention is not limited to the written content of the gestalt of the above-mentioned implementation, for example, may be carried out as follows.
[0048]
It is good also as a configuration which computes the amount of internals EGR by applying the exhaust gas pressure in the engine exhaust pipe 24 as a parameter. in this case, exhaust gas pressure -- responding -- the amount of clearance-volume EGR(s) -- or it blows back and the amount of EGR(s) changes. so that exhaust gas pressure specifically becomes large -- the amount of clearance-volume EGR(s) -- or it blows back and it is thought that the amount of EGR(s) increases. if exhaust gas pressure is applied as a parameter -- the amount of clearance-volume EGR(s) -- it blows back, the amount of EGR(s) can compute to accuracy more, and, as a result, the calculation precision of the amount of internals EGR improves. Therefore, the restoration air content Gn in a cylinder is computable with a sufficient precision also at the time of change of exhaust gas pressure.
[0049]
It is good also as a configuration which computes the amount of internals EGR by adding as a parameter the opening of the waist gate valve prepared with the engine equipped with the turbo (supercharger) so that the exhaust gas turbine of the turbo concerned might be detoured. since [in this case,] exhaust gas pressure will change if the opening of a waist gate valve changes -- the amount of clearance-volume EGR(s) -- or it blows back and the amount of EGR(s) changes. since exhaust gas pressure specifically becomes large so that a waist gate valve opening is small -- the amount of clearance-volume EGR(s) -- or it blows back and it is thought that the amount of EGR(s) increases. It blows back in drawing 9 with a waist gate valve opening, and relation with the amount of EGR(s) is shown in it. if a waist gate valve opening is added to a parameter -- the amount of clearance-volume EGR(s) -- it blows back, the amount of EGR(s) can compute to accuracy more, and, as a result, the calculation precision of the amount of internals EGR improves. Therefore, the restoration air content Gn in a cylinder is computable with a sufficient precision also at the time of opening modification of a waist gate valve.
[0050]
Although it considered as the configuration which computes the amount of internals EGR by those addition with the gestalt of the above-mentioned implementation after blowing back with the amount of clearance-volume EGR(s) and computing the amount of EGR(s) respectively, it is also possible to compute the amount of internals EGR directly on a map etc., without changing this configuration, blowing back with a clearance volume EGR, and dividing EGR. Even if it is this case, simplification of operation logic and improvement in calculation precision of the restoration air content Gn in a cylinder can be aimed at as stated above by computing the basic restoration air content Gnb and the amount Gegr of internals EGR according to an individual. It is good to compute the basic restoration air content Gnb and the amount Gegr of internals EGR according to an individual using each map data etc.
[0051]
This is changed although considered as the configuration which computes the amount of internals EGR according to the closing motion stage of an intake valve and an exhaust air bulb fundamentally with the gestalt of the above-mentioned implementation. For example, in the engine equipped with the adjustable valve gear which makes the amount of valve lifts adjustable, the amount of internals EGR is computed by making the amount of valve lifts into a parameter.
[0052]
This may be changed although the restoration air content Gn in a cylinder was computed with the gestalt of the above-mentioned implementation by having subtracted the amount Gegr of internals EGR from the basic

restoration air content Gnb. For example, the restoration air content Gn in a cylinder is computed by setting up a correction factor with the amount Gegr of internals EGR (however, correction factor <1), and this correction factor amending the basic restoration air content Gnb.

[Brief Description of the Drawings]

[0053]

[Drawing 1] It is the block diagram showing the outline of the engine control system in the gestalt of implementation of invention.

[Drawing 2] It is drawing showing lift actuation of an intake valve and an exhaust air bulb.

[Drawing 3] It is drawing for blowing back with a clearance volume EGR and explaining EGR.

[Drawing 4] It is drawing showing the relation between a clearance volume EGR and an exhaust air bulb close stage.

[Drawing 5] It is drawing in which blowing back and showing the relation between EGR and the amount of valves overlap.

[Drawing 6] It is the functional block diagram of ECU about the operation of the restoration air content in a cylinder.

[Drawing 7] It is drawing for computing a basic air content.

[Drawing 8] It is drawing for computing a pulsating correction factor.

[Drawing 9] It is drawing in which blowing back with a waist gate valve opening and showing relation with the amount of EGR(s).

[Description of Notations]

[0054]

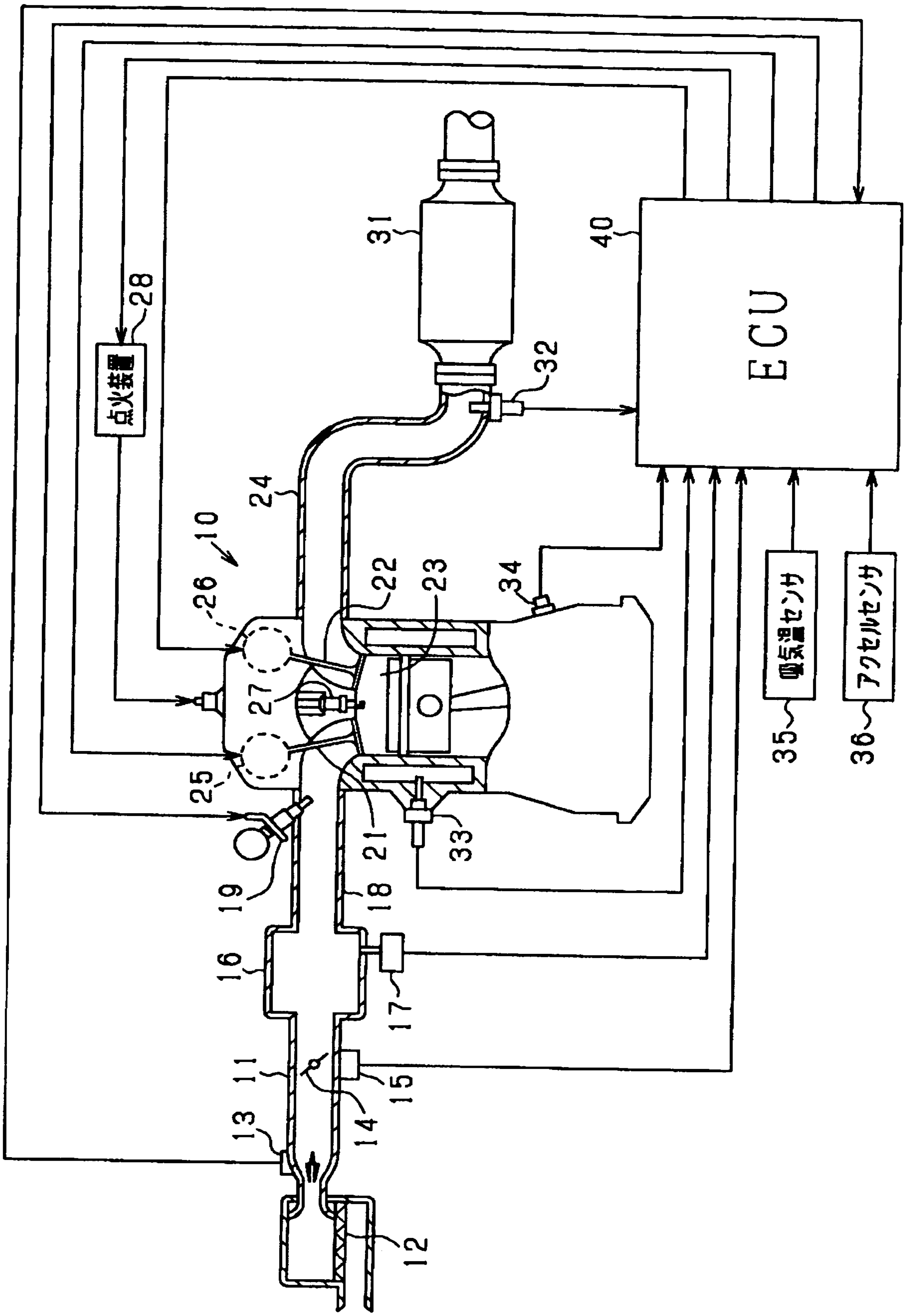
10 [-- An exhaust air bulb, 24 / -- 25 An exhaust pipe, 26 / -- An adjustable valve gear, 40 / -- ECU.] -- An engine, 11 -- An inlet pipe, 21 -- An intake valve, 22

[Translation done.]

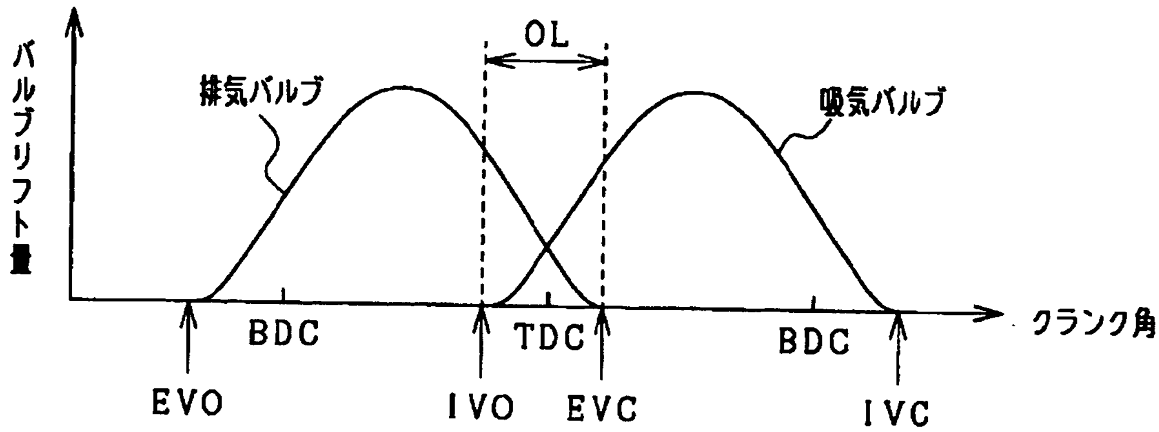
* NOTICES *

DRAWINGS

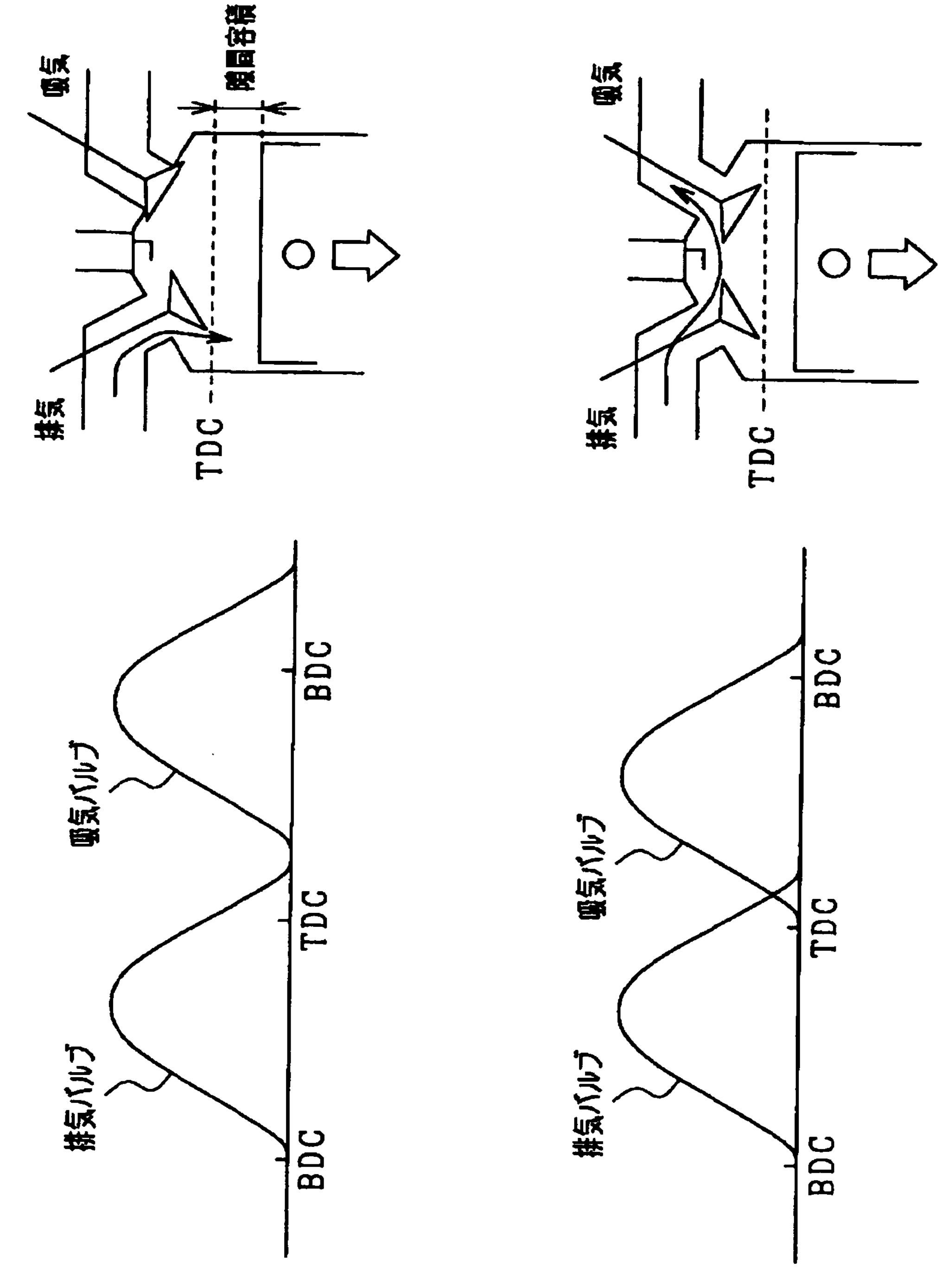
[Drawing 1]


ECU
点火装置
吸気温センサ
アクセルセンサ
10
11
12
13
14
15
16
17
18
19
21
22
23
24
25
26
27
28
31
32
33
34
35
36
40

[Drawing 2]



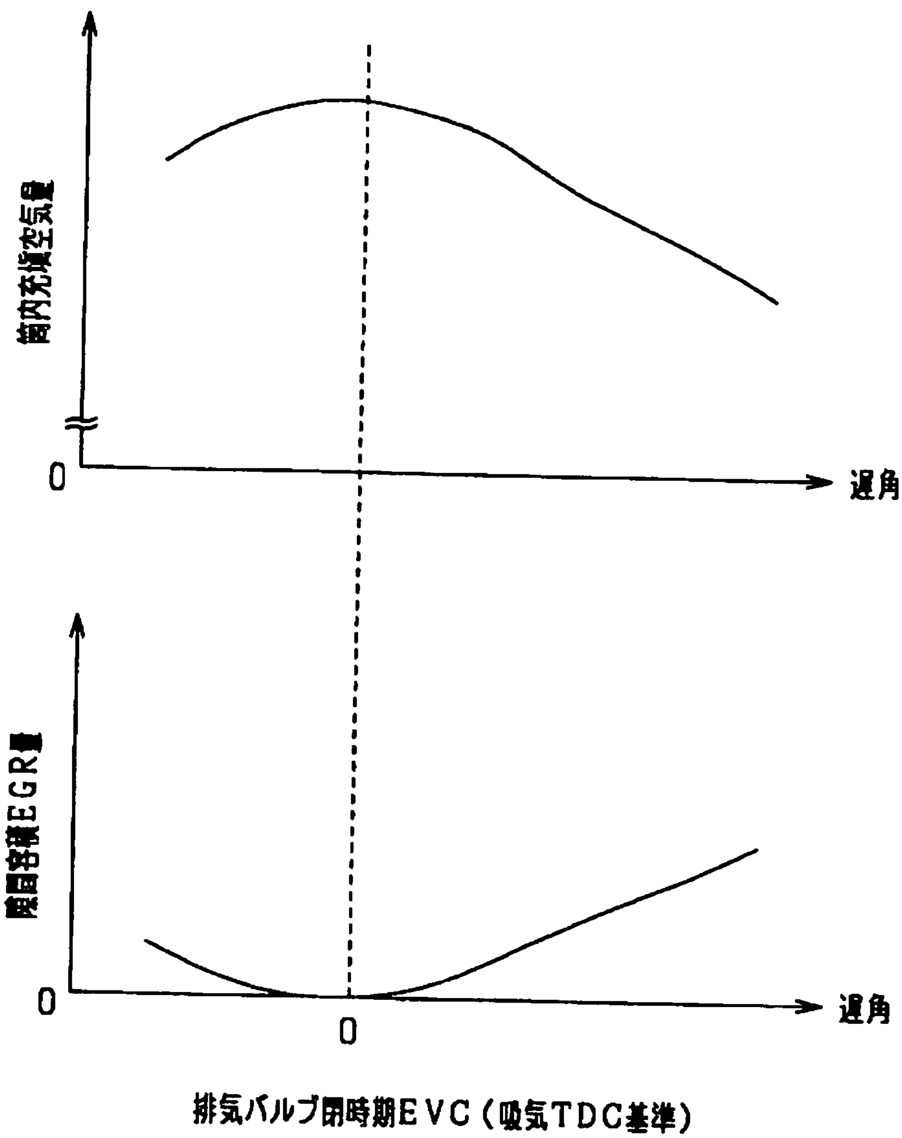
[Drawing 3]



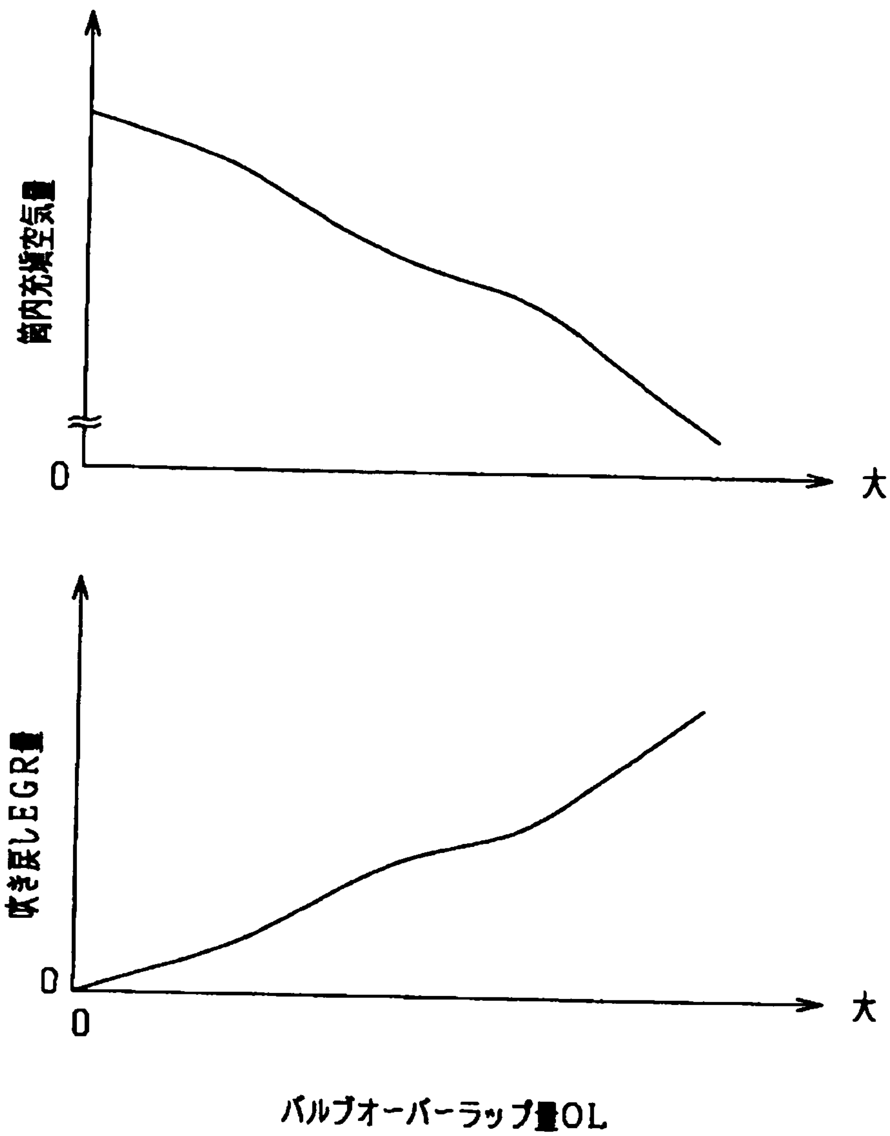
(a)

(b)

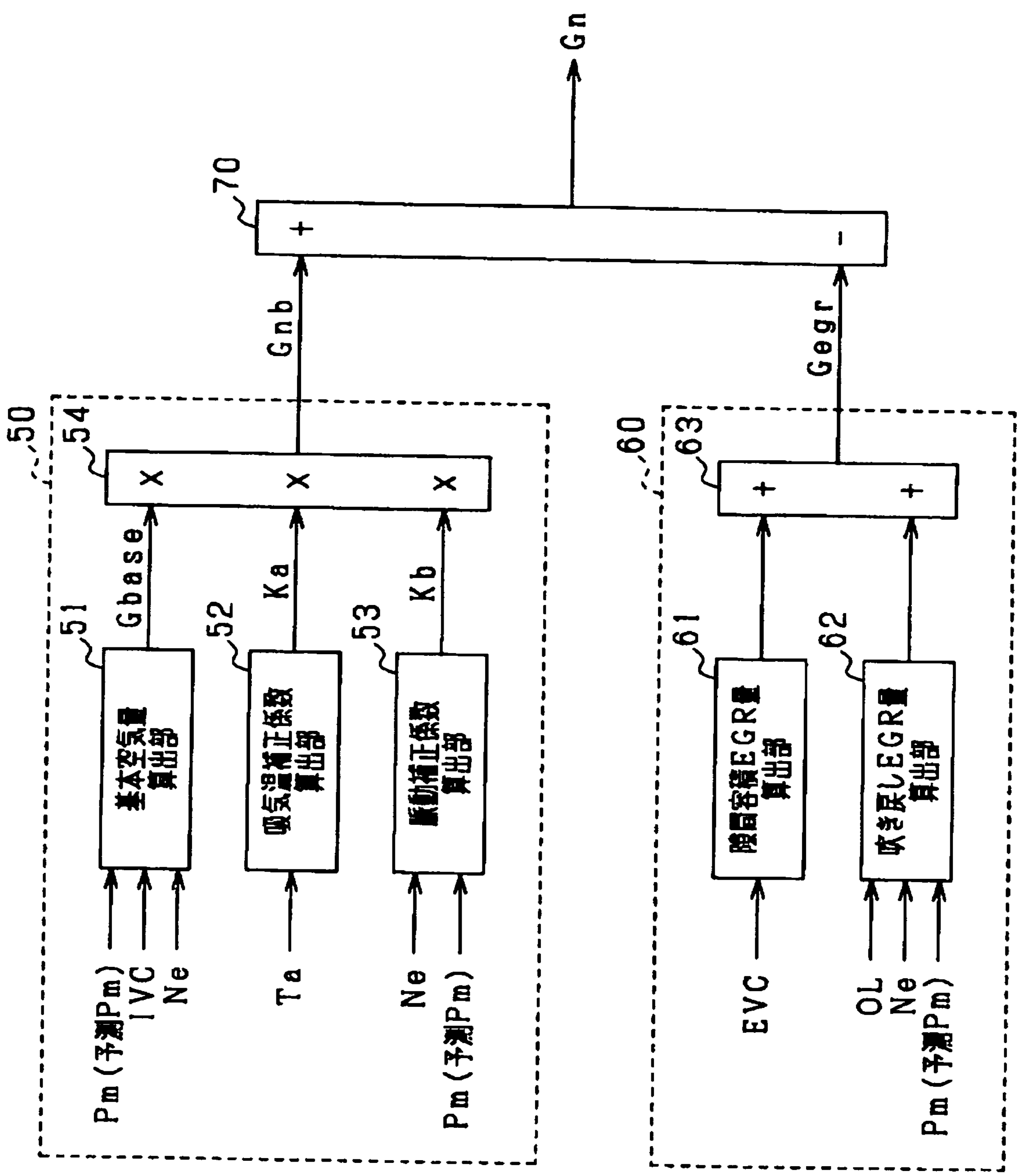
[Drawing 4]



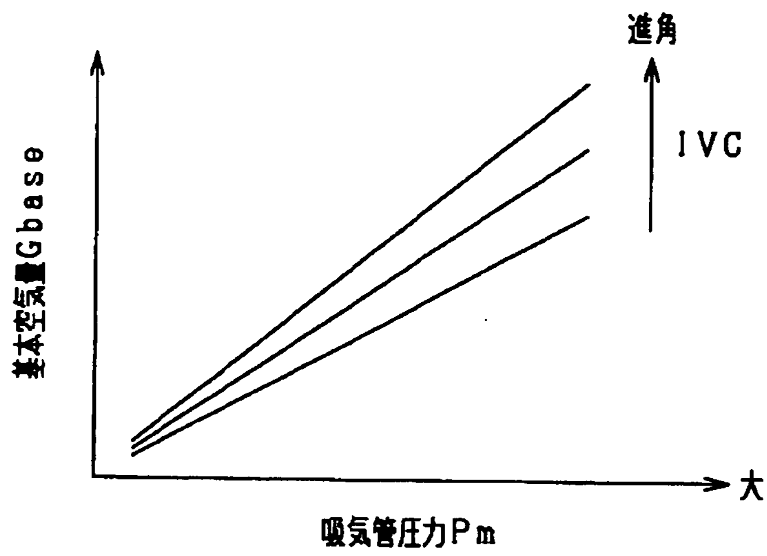
[Drawing 5]



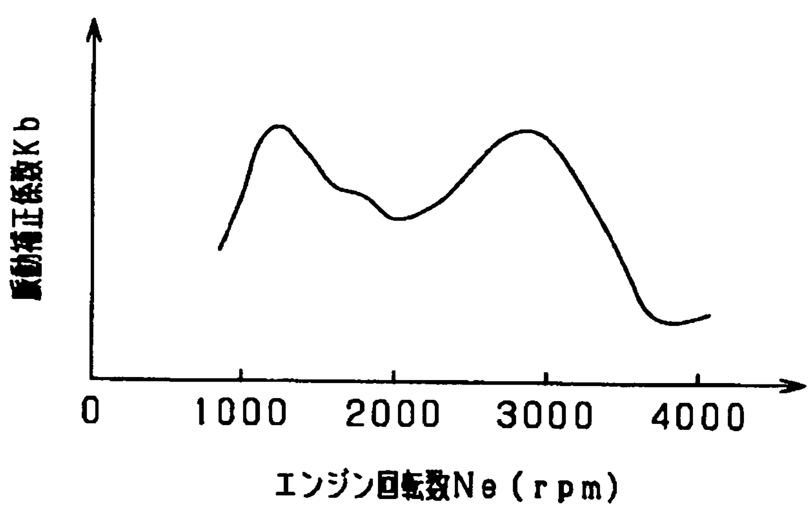
[Drawing 6]


Gn
70
+
−
Gnb
Gegr
50
54
×
Gbase
Ka
Kb
51
基本空気量算出部
52
吸気温補正係数算出部
53
脈動補正係数算出部
Pm（予測Pm）
IVC
Ne
Ta
60
63
+
61
隙間容積EGR量算出部
62
吹き戻しEGR量算出部
EVC
OL

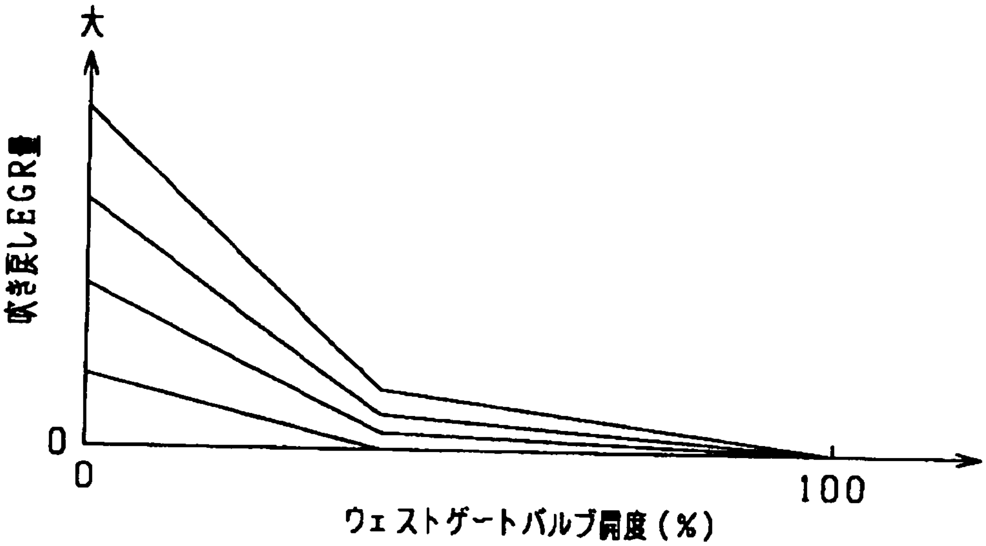
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]

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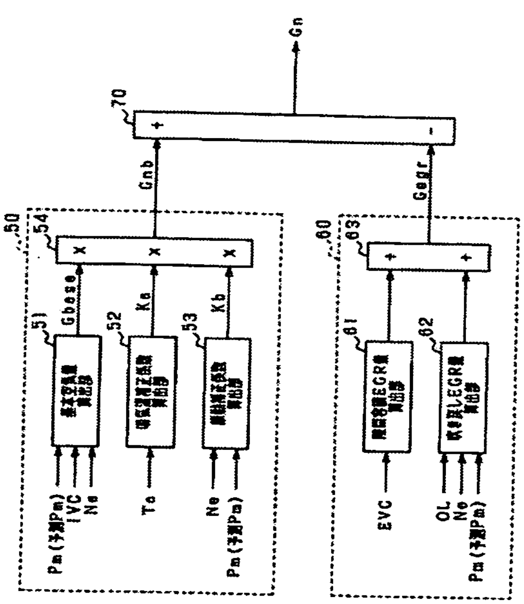
(71) 出願人 000004260
株式会社デンソー
愛知県刈谷市昭和町１丁目１番地
(74) 代理人 100096998
弁理士　碓氷　裕彦
(74) 代理人 100118197
弁理士　加藤　大登
(74) 代理人 100123191
弁理士　伊藤　高順
(72) 発明者 田中　誠
愛知県刈谷市昭和町１丁目１番地　株式会社デンソー内
(72) 発明者 大林　秀樹
愛知県刈谷市昭和町１丁目１番地　株式会社デンソー内

最終頁に続く

(54)【発明の名称】内燃機関の空気量算出装置

(57)【要約】
【課題】演算ロジックの簡素化を図りつつ、筒内充填空気量を精度良く算出する。
【解決手段】基本充填空気量算出部５０は、基本空気量Ｇｂａｓｅ、吸気温補正係数Ｋａ、脈動補正係数Ｋｂをそれぞれ算出すると共に、これらにより基本充填空気量Ｇｎｂを算出する。また、内部ＥＧＲ量算出部６０は、排気バルブ閉時期ＥＶＣに基づいて隙間容積ＥＧＲ量を算出すると共に、バルブオーバーラップ量ＯＬ、エンジン回転数Ｎｅ及び吸気管圧力Ｐｍに基づいて吹き戻しＥＧＲ量を算出し、更に隙間容積ＥＧＲ量と吹き戻しＥＧＲ量との加算により内部ＥＧＲ量Ｇｅｇｒを算出する。そして、筒内充填空気量算出部７０は、基本充填空気量ＧｎｂからＩ内部ＥＧＲ量Ｇｅｇｒを減算して筒内充填空気量Ｇｎを算出する。
【選択図】　図６



【特許請求の範囲】

【請求項１】

吸気バルブと排気バルブの少なくとも一方の開閉時期又はリフト量を可変とする可変動弁手段を備えた内燃機関の筒内充填空気量算出装置において、

内燃機関の運転領域に基づいて基本空気量を算出する基本空気量算出手段と、

前記可変動弁手段による吸気バルブ又は排気バルブの開閉時期等によって発生する内部ＥＧＲのガス量を算出する内部ＥＧＲ量算出手段と、

前記基本空気量と内部ＥＧＲ量により前記筒内充填空気量を算出する筒内充填空気量算出手段と、

を備えたことを特徴とする内燃機関の空気量算出装置。

【請求項２】

前記内部ＥＧＲ量算出手段は、吸気管圧力、機関回転数、排気バルブの閉時期、吸気バルブ及び排気バルブの開弁オーバーラップ量に基づいて内部ＥＧＲ量を算出する請求項１に記載の内燃機関の空気量算出装置。

【請求項３】

前記内部ＥＧＲ量算出手段は、内燃機関の排気通路内の排気圧力をパラメータとして加えて内部ＥＧＲ量を算出する請求項２に記載の内燃機関の空気量算出装置。

【請求項４】

排気通路に設けられたタービンに、吸気通路に設けられたコンプレッサが連結され、タービンを作動することにより内燃機関に供給される吸気を過給する過給機を備え、前記排気通路をバイパスして過給圧を調整するウェストゲートバルブを設けた内燃機関に適用され、

前記内部ＥＧＲ量算出手段は、前記ウェストゲートバルブの開度をパラメータとして加えて内部ＥＧＲ量を算出する請求項２に記載の内燃機関の空気量算出装置。

【請求項５】

前記内部ＥＧＲ量算出手段は、燃焼後に気筒内に残留する既燃ガス量である第１ガス量を算出する手段と、吸気通路側に吹き戻される既燃ガス量である第２ガス量を算出する手段とを備え、これら第１ガス量と第２ガス量とを加算して内部ＥＧＲ量を算出する請求項１に記載の内燃機関の空気量算出装置。

【請求項６】

前記内部ＥＧＲ量算出手段は、少なくとも排気バルブの閉時期に基づいて前記第１ガス量を算出する請求項５に記載の内燃機関の空気量算出装置。

【請求項７】

前記内部ＥＧＲ量算出手段は、少なくとも吸気バルブ及び排気バルブの開弁オーバーラップ量に基づいて前記第２ガス量を算出する請求項５又は６に記載の内燃機関の空気量算出装置。

【請求項８】

前記内部ＥＧＲ量算出手段は、内燃機関の排気通路内の排気圧力をパラメータとして加えて前記第１ガス量、前記第２ガス量の少なくとも一方を算出する請求項５乃至７の何れかに記載の内燃機関の空気量算出装置。

【請求項９】

排気通路に設けられたタービンに、吸気通路に設けられたコンプレッサが連結され、タービンを作動することにより内燃機関に供給される吸気を過給する過給機を備え、前記排気通路をバイパスして過給圧を調整するウェストゲートバルブを設けた内燃機関に適用され、

前記内部ＥＧＲ量算出手段は、前記ウェストゲートバルブの開度をパラメータとして加えて前記第１ガス量、前記第２ガス量の少なくとも一方を算出する請求項５乃至７の何れかに記載の内燃機関の空気量算出装置。

【請求項１０】

将来のバルブ開閉時期等の変化を予測する手段を備え、前記内部ＥＧＲ量算出手段は、

前記予測した将来のバルブ開閉時期等に基づいて内部ＥＧＲ量を算出する請求項１乃至９の何れかに記載の内燃機関の空気量算出装置。

【請求項１１】

内燃機関の将来の負荷を予測する手段を備え、前記基本空気量算出手段は、前記予測した将来の負荷をパラメータとして用い基本空気量を算出する請求項１乃至１０の何れかに記載の内燃機関の空気量算出装置。

【請求項１２】

前記基本空気量算出手段は、内燃機関の回転数、負荷、吸気バルブの閉時期に基づいて基本空気量を算出する請求項１乃至１１の何れかに記載の内燃機関の空気量算出装置。

【請求項１３】

所定の負荷以上となる機関運転状態で、機関回転数に対応して生じる吸気脈動の影響を解消するよう前記基本空気量を補正する手段を更に備えた請求項１乃至１２の何れかに記載の内燃機関の空気量算出装置。

【請求項１４】

前記吸気通路より吸入される空気の温度に応じて前記基本空気量を補正する手段を更に備えた請求項１乃至１３の何れかに記載の内燃機関の空気量算出装置。

【発明の詳細な説明】

【技術分野】

【０００１】

本発明は、可変動弁手段を備えた内燃機関において、当該内燃機関の気筒内に充填される筒内充填空気量を精度良く算出するための内燃機関の空気量算出装置に関するものである。

【背景技術】

【０００２】

内燃機関の気筒内に充填される筒内充填空気量を算出し、その筒内充填空気量に基づいて燃料噴射量や点火時期を制御する技術がある。この場合、筒内充填空気量は実際に気筒内に閉じこめられ、気筒内での燃焼に関与する空気量であるため、この筒内充填空気量をパラメータとして用いることで燃料噴射量や点火時期の制御の高精度化が可能となる。筒内充填空気量の算出手法としては、機関回転数と吸気管圧力とに基づいて算出するものがある。

【０００３】

ところで近年では、可変動弁手段を備えた内燃機関が数多く実用化されており、可変動弁手段により吸気バルブや排気バルブの開閉時期等が調整され、出力や燃費の改善等が図られている。またこの場合、吸気バルブや排気バルブの開閉時期等が調整されることにより、いわゆる内部ＥＧＲが発生する。この可変動弁手段を備えた内燃機関では、吸気管圧力が同一であってもバルブ開閉時期等が変更されることで内部ＥＧＲの状態が大きく変化し、筒内充填空気量が正確に算出できないという問題が生じる。また、内部ＥＧＲの影響を反映すべく、機関運転領域やバルブ開閉時期等の各パラメータについて全ての組み合わせで適合を行うことも考えられるが、これでは適合工数や演算処理負荷が増加するという問題を招いてしまう。

【０００４】

なお、可変動弁手段を備えた内燃機関の空気量検出装置として、例えば特許文献１の技術が知られている。この特許文献１では、点火時期制御においてエアフロメータにより吸入空気量を検出し、吸気バルブ開時期及び吸気バルブ閉時期における吸入空気量の平均値、又は吸気バルブ開期間の中間点における吸入空気量を筒内充填空気量としている。そして、この筒内充填空気量により点火時期を演算する構成としていた。しかしながら、かかる構成では、基本的にエアフロメータの検出結果から筒内充填空気量を求め、その筒内充填空気量に基づいて点火時期制御を実施しており、エアフロメータの検出遅れや吸入空気の吸気管通過遅れにより、過渡時に充填空気量を正確に算出できないという問題が生じる。

【特許文献１】特開平９－３０３２４２号公報

【発明の開示】

【発明が解決しようとする課題】

【０００５】

本発明は、演算ロジックの簡素化を図りつつ、筒内充填空気量を精度良く算出することができる内燃機関の空気量算出装置を提供することを主たる目的とするものである。

【課題を解決するための手段】

【０００６】

可変動弁手段を備えた内燃機関では、吸気バルブ又は排気バルブの開閉時期やリフト量の変更を要因として内部ＥＧＲ量が大きく変化し、それにより気筒内に充填される新気の量（筒内充填空気量）が変化する。ここで、請求項１に記載の発明では、内燃機関の運転領域に基づいて基本空気量が算出されると共に、可変動弁手段による吸気バルブ又は排気バルブの開閉時期等によって発生する内部ＥＧＲのガス量（内部ＥＧＲ量）が算出され、更に基本空気量と内部ＥＧＲ量により筒内充填空気量が算出される。この場合、基本空気量と内部ＥＧＲ量とが個別に算出されることにより、吸気バルブ又は排気バルブの開閉時期等の変更に伴う内部ＥＧＲの発生時にも筒内充填空気量が精度良く算出できる。また、既存の技術において筒内充填空気量を精度良く求めるには、機関回転数や負荷といった運転領域パラメータ以外に吸気バルブや排気バルブの開閉時期等もパラメータとして加え、全てのパラメータの組み合わせで予め適合を行う必要があり、適合工数の増大や演算処理負荷の増加といった問題が生じていた。これに対し本発明では、内部ＥＧＲ量を別途算出することとしたため、その分適合の組み合わせを減らすことができる。以上により、演算ロジックの簡素化を図りつつ、筒内充填空気量を精度良く算出することができる。なお、簡易には、基本空気量から内部ＥＧＲ量を減算して筒内充填空気量を算出すると良い。

【０００７】

請求項２に記載の発明では、吸気管圧力、機関回転数、排気バルブの閉時期、吸気バルブ及び排気バルブの開弁オーバーラップ量に基づいて内部ＥＧＲ量が算出される。この場合、吸気管圧力、機関回転数、排気バルブの閉時期、吸気バルブ及び排気バルブの開弁オーバーラップ量によって内部ＥＧＲ量が変化するため、これらをパラメータとすれば内部ＥＧＲ量を正確に算出できる。

【０００８】

請求項３に記載の発明では、内燃機関の排気通路内の排気圧力をパラメータとして加えて内部ＥＧＲ量が算出される。排気圧力が変わると内部ＥＧＲ量が変化する。この場合、排気圧力をパラメータとすれば内部ＥＧＲ量がより正確に算出できる。従って、排気圧力の変化時にも筒内充填空気量を精度良く算出することができる。

【０００９】

請求項４に記載の発明では、過給圧調整のためのウェストゲートバルブを設けた内燃機関において、ウェストゲートバルブの開度をパラメータとして加えて内部ＥＧＲ量が算出される。ウェストゲートバルブの開度が変わると排気圧力が変化するため、内部ＥＧＲ量が変化する。この場合、ウェストゲートバルブの開度をパラメータとすれば内部ＥＧＲ量がより正確に算出できる。従って、ウェストゲートバルブの開度変更時にも筒内充填空気量を精度良く算出することができる。

【００１０】

また、請求項５に記載の発明では、燃焼後に気筒内に残留する既燃ガス量である第１ガス量が算出されると共に、吸気通路側に吹き戻される既燃ガス量である第２ガス量が算出され、これら第１ガス量と第２ガス量との加算により内部ＥＧＲ量が算出される。この場合、内部ＥＧＲの発生要因に合わせて正確に内部ＥＧＲ量が算出できるようになり、ひいては筒内充填空気量の算出精度が向上する。例えば、第１ガス量算出用のマップと、第２ガス量算出用のマップとを各々用意することにより、簡易に内部ＥＧＲガス量が算出できるようになる。

【００１１】

ここで、第１ガス量は、排気バルブが閉じた時に排気通路側に排出されずに残留した既燃ガス量であり、基本的に排気バルブが閉じる時の筒内容積（これを隙間容積とも言う）に依存する。故に、請求項６に記載したように、少なくとも排気バルブの閉時期に基づいて第１ガス量が算出されると良い。具体的には、排気バルブの閉時期が吸気ＴＤＣから離れるほど、第１ガス量が大きくなるよう算出される。

【００１２】

また、第２ガス量は、吸気バルブと排気バルブとが共に開弁しているオーバーラップ期間中に吸気通路側に吹き戻される既燃ガス量であり、基本的に前記両バルブの開弁オーバーラップ量に依存する。故に、請求項７に記載したように、少なくとも吸気バルブ及び排気バルブの開弁オーバーラップ量に基づいて第２ガス量が算出されると良い。具体的には、オーバーラップ量が大きいほど、第２ガス量が大きくなるよう算出される。なお、オーバーラップ量以外に、機関回転数や吸気通路内圧力をパラメータとして加え、第２ガス量を算出する構成とすることも可能である。

【００１３】

請求項８に記載の発明では、内燃機関の排気通路内の排気圧力をパラメータとして加えて前記第１ガス量、前記第２ガス量の少なくとも一方が算出される。排気圧力が変わると、気筒内に残留する既燃ガス量、又は吸気通路側に吹き戻される既燃ガス量が変化する。排気圧力をパラメータとすれば第１ガス量、第２ガス量がより正確に算出でき、その結果内部ＥＧＲ量の算出精度が向上する。従って、排気圧力の変化時にも筒内充填空気量を精度良く算出することができる。

【００１４】

請求項９に記載の発明では、過給圧調整のためのウェストゲートバルブを設けた内燃機関において、ウェストゲートバルブの開度をパラメータとして加えて前記第１ガス量、前記第２ガス量の少なくとも一方が算出される。ウェストゲートバルブの開度が変わると排気圧力が変化するため、気筒内に残留する既燃ガス量、又は吸気通路側に吹き戻される既燃ガス量が変化する。ウェストゲートバルブの開度をパラメータとすれば第１ガス量、第２ガス量がより正確に算出でき、その結果内部ＥＧＲ量の算出精度が向上する。従って、ウェストゲートバルブの開度変更時にも筒内充填空気量を精度良く算出することができる。

【００１５】

請求項１０に記載の発明では、将来のバルブ開閉時期等の変化が予測され、該予測された将来のバルブ開閉時期等に基づいて内部ＥＧＲ量が算出される。この場合、将来のバルブ開閉時期等の変化を反映して内部ＥＧＲ量が算出されるため、運転条件が急変する過渡時等にも筒内充填空気量を精度良く算出することが可能となる。

【００１６】

請求項１１に記載の発明では、内燃機関の将来の負荷が予測され、該予測された将来の負荷をパラメータとして基本空気量が算出される。この場合、将来の負荷変化を反映して基本空気量が算出されるため、運転条件が急変する過渡時等にも筒内充填空気量を精度良く算出することが可能となる。

【００１７】

請求項１２に記載の発明では、内燃機関の回転数、負荷、吸気バルブの閉時期に基づいて基本空気量が算出される。この場合、機関回転数や負荷により、吸気系から気筒に給送される空気量が決まり、吸気バルブの閉時期により、給送される空気のどれだけが気筒内に充填されるかが決まる。機関回転数、負荷、吸気バルブの閉時期をパラメータとして基本空気量を算出する構成では、当該基本空気量が精度良く算出できる。

【００１８】

請求項１３に記載の発明では、所定の負荷以上となる機関運転状態で、機関回転数に対応して生じる吸気脈動の影響を解消するよう前記基本空気量が補正される。基本空気量は、内燃機関の低中負荷状態では概ね負荷に比例し、高負荷状態（例えばＷＯＴ状態）では吸気脈動の影響を受けて変動する。この吸気脈動は特定の機関回転域で発生することから

、機関回転数に応じて補正量を定め、その補正量により基本空気量を補正すると良い。これにより、吸気脈動の影響が解消され、筒内充填空気量の算出精度が向上する。

【００１９】

請求項１４に記載の発明では、前記吸気通路より吸入される空気の温度に応じて前記基本空気量が補正される。吸入空気の温度が変化すると、密度変化により基本空気量が変化する。吸入空気の温度に応じて基本空気量を補正することにより、筒内充填空気量の算出精度が向上する。

【発明を実施するための最良の形態】

【００２０】

以下、本発明を具体化した一実施の形態を図面に従って説明する。本実施の形態は、内燃機関である車載用多気筒4サイクルエンジンを対象にエンジン制御システムを構築するものとしており、当該制御システムにおいては電子制御ユニット（以下、ＥＣＵという）を中枢として燃料噴射量の制御や点火時期の制御等を実施することとしている。先ずは、図１を用いてエンジン制御システムの全体概略構成図を説明する。

【００２１】

図１に示すエンジン１０において、吸気管１１の最上流部にはエアクリーナ１２が設けられ、このエアクリーナ１２の下流側には吸入空気量を検出するためのエアフロメータ１３が設けられている。エアフロメータ１３の下流側には、ＤＣモータ等のアクチュエータによって開度調節されるスロットルバルブ１４と、スロットル開度を検出するためのスロットル開度センサ１５とが設けられている。スロットルバルブ１４の下流側にはサージタンク１６が設けられ、このサージタンク１６には吸気管圧力を検出するための吸気管圧力センサ１７が設けられている。また、サージタンク１６には、エンジン１０の各気筒に空気を導入する吸気マニホールド１８が接続されており、吸気マニホールド１８において各気筒の吸気ポート近傍には燃料を噴射供給する電磁駆動式の燃料噴射弁１９が取り付けられている。

【００２２】

エンジン１０の吸気ポート及び排気ポートにはそれぞれ吸気バルブ２１及び排気バルブ２２が設けられており、吸気バルブ２１の開動作により空気と燃料との混合気が燃焼室２３内に導入され、排気バルブ２２の開動作により燃焼後の排ガスが排気管２４に排出される。吸気バルブ２１及び排気バルブ２２にはそれぞれ可変動弁機構２５，２６が設けられている。これら可変動弁機構２５，２６は、各バルブ２１，２２の開閉タイミングを連続的に可変とすることができる構造を有し、その都度のアクセル開度やエンジン運転状態等に応じてバルブ開閉タイミングが適宜調整されるようになっている。

【００２３】

エンジン１０のシリンダヘッドには各気筒毎に点火プラグ２７が取り付けられており、点火プラグ２７には、点火コイル等よりなる点火装置２８を通じて、所望とする点火時期において高電圧が印加される。この高電圧の印加により、各点火プラグ２７の対向電極間に火花放電が発生し、燃焼室２３内に導入した混合気が着火され燃焼に供される。

【００２４】

排気管２４には、排出ガス中のＣＯ，ＨＣ，ＮＯｘ等を浄化するための三元触媒等の触媒３１が設けられ、この触媒３１の上流側には排ガスを検出対象として混合気の空燃比又はリッチ／リーンを検出するための空燃比センサ３２（リニア空燃比センサ、酸素センサ等）が設けられている。また、エンジン１０のシリンダブロックには、冷却水温を検出する冷却水温センサ３３や、エンジン１０の所定クランク角毎に（例えば１０°ＣＡ周期で）矩形状のクランク角信号を出力するクランク角センサ３４が取り付けられている。その他に、吸入空気の温度を検出する吸気温センサ３５や、アクセルペダルの踏み込み量（アクセル開度）を検出するアクセルセンサ３６が設けられている。

【００２５】

上述した各種センサの出力は、エンジン制御を司るＥＣＵ４０に入力される。ＥＣＵ４０は、ＣＰＵ、ＲＯＭ、ＲＡＭ等よりなるマイクロコンピュータを主体として構成され、

ＲＯＭに記憶された各種の制御プログラムを実行することで、エンジン運転状態に基づいて燃料噴射弁１９による燃料噴射、点火プラグ２７による点火時期、可変動弁機構２５，２６による吸気バルブ２１及び排気バルブ２２の開閉タイミングなどを制御する。

【００２６】

図２には、吸気バルブ２１及び排気バルブ２２のリフト動作を示しており、同図２において、ＥＶＯは排気バルブ開時期、ＥＶＣは排気バルブ閉時期、ＩＶＯは吸気バルブ開時期、ＩＶＣは吸気バルブ閉時期、ＯＬはバルブオーバーラップ量である。各バルブ２１，２２の開閉時期は可変動弁機構２５，２６により調整され、吸気バルブ開閉時期は最遅角位置を基準にして進角側に、排気バルブ開閉時期は最進角位置を基準にして遅角側に、それぞれ制御される。このとき、吸気バルブ側の進角制御と排気バルブ側の遅角制御とにより、各バルブが共に開状態となるバルブオーバーラップが生じる。なお本実施の形態では、吸気バルブ２１は最遅角状態でＩＶＯ＝吸気ＴＤＣ後４０°ＣＡとし、その最遅角位置から最大６０°ＣＡ進角できる構成としている。また、排気バルブ２２は最進角状態でＥＶＣ＝吸気ＴＤＣ前４°ＣＡとし、その最進角位置から最大６０°ＣＡ遅角できる構成としている。

【００２７】

ここで、排気バルブ２２が遅角側に制御されるか、又はバルブオーバーラップ量が大きくなると内部ＥＧＲが増加する。本実施の形態では、内部ＥＧＲを、排気バルブ閉時期の遅角化を要因とするＥＧＲ分と、バルブオーバーラップを要因とするＥＧＲ分とに分けて考えることとし、そのメカニズムを図３により説明する。

【００２８】

図３の（ａ）では、排気バルブ閉時期ＥＶＣがＴＤＣ後となっている（但し、バルブオーバーラップはないものとしている）。この場合、ＴＤＣを過ぎ、ピストンが上昇から下降に転じた後でも排気バルブ２２が開いているため、排気ポートより気筒内（燃焼室２３内）に既燃ガスが流入する。これにより、排気バルブ２２の閉鎖後において気筒内に既燃ガスが残留し、内部ＥＧＲが発生する。筒内残留ガスによる内部ＥＧＲ量は、排気バルブ２２が閉じるまでにおいてピストンの下降により拡張された筒内容積分に依存して決まることが本願発明者により確認されている。以下、この内部ＥＧＲ量を「隙間容積ＥＧＲ量」と言う。このとき、排気バルブ閉時期ＥＶＣでの筒内容積が隙間容積であり、排気バルブ閉時期ＥＶＣに応じて隙間容積ＥＧＲ量が算出できる。

【００２９】

また、図３の（ｂ）では、バルブオーバーラップが生じている。この場合、吸気バルブ２１と排気バルブ２２とが同時に開くため、既燃ガスが吸気側に吹き戻される。これにより、後続の吸気行程において既燃ガスが気筒内に再流入し、内部ＥＧＲが発生する。吹き戻しによる内部ＥＧＲ量は、バルブオーバーラップ量に依存して決まることが本願発明者により確認されている。以下、この内部ＥＧＲ量を「吹き戻しＥＧＲ量」と言う。このとき、バルブオーバーラップ量に応じて吹き戻しＥＧＲ量が算出できる。

【００３０】

内部ＥＧＲ量が増えると、そのＥＧＲ量に応じて気筒内に充填される空気量（筒内充填空気量）が減少する。このとき、隙間容積ＥＧＲ、吹き戻しＥＧＲにより筒内充填空気量の減少が生じ、先ず隙間容積ＥＧＲについては、図４に示すように、排気バルブ閉時期ＥＶＣが吸気ＴＤＣを基準に遅角側に移行するほど隙間容積ＥＧＲ量が増え、それに伴い筒内充填空気量が減少する。また、吹き戻しＥＧＲについては、図５に示すように、バルブオーバーラップ量ＯＬが大きくなるほど、吹き戻しＥＧＲ量が増え、それに伴い筒内充填空気量が減少する。

【００３１】

燃料噴射量制御や点火時期制御の制御精度を向上させるには、吸気バルブ２１が閉じた時点で実際にエンジン気筒内に充填される新気の量（筒内充填空気量Ｇｎ）を精度良く把握することを要する。そこで本実施の形態では、前記内部ＥＧＲによる筒内充填空気量の減少分を補正することで、筒内充填空気量の算出精度向上を図ることとする。その他、吸

気脈動補正や吸気温補正等を行うことで、更なる筒内充填空気量の算出精度向上を図るようにする。

【００３２】

筒内充填空気量Ｇｎは、例えば燃料噴射量の演算時においてその演算パラメータとして算出され、実際には将来の過渡変化等も考慮して算出される。具体的には、吸気管圧力Ｐｍを基に筒内充填空気量Ｇｎを算出する構成としており、将来の吸気管圧力Ｐｍを予測し、その予測Ｐｍを用いて筒内充填空気量Ｇｎを算出する。なお、吸気管圧力Ｐｍの予測手法としては、例えばスロットル遅延モデルを用いたものが適用でき、運転者により操作されるアクセル開度から将来のスロットル開度を予測し、その予測スロットル開度に基づいて将来の吸気管圧力Ｐｍを予測している。

【００３３】

図６は、筒内充填空気量の演算に関するＥＣＵ４０の機能ブロック図である。ここで、筒内充填空気量Ｇｎの演算に用いる吸気管圧力Ｐｍは何れも前述の予測Ｐｍであり、エンジン回転数Ｎｅ、吸気温Ｔａといった各パラメータは各種センサの検出結果に基づく値である。

【００３４】

図６では、主要な構成として基本充填空気量算出部５０と内部ＥＧＲ量算出部６０とを設けており、基本充填空気量算出部５０にて基本充填空気量Ｇｎｂが算出され、内部ＥＧＲ量算出部６０にて内部ＥＧＲ量Ｇｅｇｒが算出される。先ずは基本充填空気量算出部５０について詳しく説明する。基本充填空気量算出部５０において、基本空気量算出部５１は、吸気管圧力Ｐｍ、吸気バルブ閉時期ＩＶＣ、エンジン回転数Ｎｅに基づいて基本空気量Ｇｂａｓｅを算出する。このとき、例えば図７に示す基本空気量マップを用い、その都度のＰｍ、ＩＶＣ、Ｎｅをパラメータとして基本空気量Ｇｂａｓｅを算出する。図７の基本空気量マップでは、内部ＥＧＲ量が最小となる条件下での基本空気量Ｇｂａｓｅが算出されるようになっており、エンジン回転数毎に概ね吸気管圧力Ｐｍが大きいほど、又は吸気バルブ閉時期ＩＶＣが進角側であるほど、基本空気量Ｇｂａｓｅが大きくなるような関係が定められている。

【００３５】

吸気温補正係数算出部５２は、その都度の吸気温Ｔａに基づいて吸気温補正係数Ｋａを算出する。このとき、吸気温Ｔａによる空気密度の変化に対応すべく、吸気温Ｔａが高いほど吸気温補正係数Ｋａを小さい値とすると良い。

【００３６】

脈動補正係数算出部５３は、エンジン回転数Ｎｅと吸気管圧力Ｐｍとに基づいて脈動補正係数Ｋｂを算出する。これは、吸気管内で発生する吸気脈動による充填空気量のばらつきを抑制するためのものであり、一例として図８に示す関係に基づいて脈動補正係数Ｋｂを算出する。但し、吸気脈動は主に高負荷状態（例えばＷＯＴ状態）で発生するため、所定の高負荷運転状態に限って脈動補正係数Ｋｂを算出すると良い。

【００３７】

基本空気量補正部５４は、基本空気量Ｇｂａｓｅに吸気温補正係数Ｋａ、脈動補正係数Ｋｂを掛け合わせて基本充填空気量Ｇｎｂを算出する（Ｇｎｂ＝Ｇｂａｓｅ×Ｋａ×Ｋｂ）。

【００３８】

また、内部ＥＧＲ量算出部６０において、隙間容積ＥＧＲ量算出部６１は、排気バルブ閉時期ＥＶＣに基づいて隙間容積ＥＧＲ量を算出する。このとき、排気バルブ閉時期ＥＶＣと隙間容積ＥＧＲ量との関係は前述の図４のとおりであり、この図４の関係に基づいて作成した隙間容積ＥＧＲマップを用いて隙間容積ＥＧＲ量を算出する。なお、排気バルブ閉時期ＥＶＣは、排気バルブ２２が将来に制御される制御予測値である。

【００３９】

吹き戻しＥＧＲ量算出部６２は、バルブオーバーラップ量ＯＬ、エンジン回転数Ｎｅ及び吸気管圧力Ｐｍに基づいて吹き戻しＥＧＲ量を算出する。このとき、バルブオーバーラ

ップ量と吹き戻しＥＧＲ量との関係は前述の図５のとおりであり、この図５の関係に基づいて作成した吹き戻しＥＧＲマップを用いて吹き戻しＥＧＲ量を算出する。また、エンジン回転数Ｎｅが高い場合には吹き戻しの時間が短縮されるために吹き戻しＥＧＲ量を少なくし、吸気管圧力Ｐｍが小さい（負圧が大きい）場合には吹き戻しの度合が増すために吹き戻しＥＧＲ量を大きくすると良い。なお、バルブオーバーラップ量ＯＬは、各バルブ２１，２２が将来に制御される制御予測値である。吸気管圧力Ｐｍに代えて、吸気管圧力と排気圧力の差圧をパラメータとすることも可能である。

【００４０】

そして、内部ＥＧＲ量算出部６３は、隙間容積ＥＧＲ量と吹き戻しＥＧＲ量とを加算して内部ＥＧＲ量Ｇｅｇｒを算出する。更に、筒内充填空気量算出部７０は、基本充填空気量Ｇｎｂから内部ＥＧＲ量Ｇｅｇｒを減算して筒内充填空気量Ｇｎを算出する。こうして算出された筒内充填空気量Ｇｎにより、燃料噴射量の演算や点火時期の演算等が行われ、それらの演算結果に基づいて燃料噴射制御や点火時期制御が実施される。

【００４１】

以上詳述した本実施の形態によれば、以下の優れた効果が得られる。

【００４２】

筒内充填空気量Ｇｎの算出に際し、基本充填空気量Ｇｎｂと内部ＥＧＲ量Ｇｅｇｒとを個別に算出し、これらＧｎｂ，Ｇｅｇｒにより筒内充填空気量Ｇｎを算出するようにしたため、内部ＥＧＲ量を反映して筒内充填空気量Ｇｎを精度良く算出することができる。このとき、基本空気量適合データとしての基本空気量マップを用いて基本空気量Ｇｂａｓｅを算出する一方、内部ＥＧＲ量適合データとしての隙間容積ＥＧＲマップ及び吹き戻しＥＧＲマップを用いて内部ＥＧＲ量を算出する構成としたため、適合の組み合わせが減り、複雑な適合が不要となる。また、各マップデータの縮小化も可能となる（マップデータの巨大化が抑制できる）。以上により、演算ロジックの簡素化を図りつつ、筒内充填空気量Ｇｎを精度良く算出することができるようになる。筒内充填空気量Ｇｎの算出精度が上がることで、燃料噴射量や点火時期の制御精度を向上させることも可能となる。

【００４３】

また、隙間容積ＥＧＲ量（第１ガス量）と吹き戻しＥＧＲ量（第２ガス量）との加算により内部ＥＧＲ量を算出する構成としたため、内部ＥＧＲの発生要因に合わせて正確に内部ＥＧＲ量が算出でき、ひいては筒内充填空気量Ｇｎの算出精度が向上する。

【００４４】

隙間容積ＥＧＲ量、吹き戻しＥＧＲ量の算出に際し、将来の制御予測値（排気バルブ閉時期ＥＶＣ、バルブオーバーラップ量ＯＬ）をパラメータとして用いる構成としたため、運転条件が急変する過渡時等にも内部ＥＧＲ量を精度良く算出することが可能となる。

【００４５】

また、基本充填空気量Ｇｎｂの算出に際し、将来の変化を見込んだ吸気管圧力Ｐｍの予測値（予測Ｐｍ）をパラメータとして用いる構成としたため、運転条件が急変する過渡時等にも基本充填空気量Ｇｎｂを精度良く算出することが可能となる。

【００４６】

基本充填空気量Ｇｎｂは、吸気バルブ閉時期において気筒内に閉じ込められる全ガス量（新気＋既燃ガス）であり、エンジン回転数Ｎｅ、吸気管圧力Ｐｍ、吸気バルブ閉時期をパラメータとすることで正確に求められる。また、吸気脈動補正や吸気温補正を行って基本充填空気量Ｇｎｂを算出するようにしたため、筒内充填空気量Ｇｎの算出精度が大いに向上する。

【００４７】

なお、本発明は上記実施の形態の記載内容に限定されず、例えば次のように実施しても良い。

【００４８】

エンジン排気管２４内の排気圧力をパラメータとして加えて内部ＥＧＲ量を算出する構成としても良い。この場合、排気圧力に応じて隙間容積ＥＧＲ量又は吹き戻しＥＧＲ量が

変化する。具体的には、排気圧力が大きくなるほど、隙間容積ＥＧＲ量又は吹き戻しＥＧＲ量が多くなると考えられる。排気圧力をパラメータとして加えれば隙間容積ＥＧＲ量、吹き戻しＥＧＲ量がより正確に算出でき、その結果内部ＥＧＲ量の算出精度が向上する。従って、排気圧力の変化時にも筒内充填空気量Ｇｎを精度良く算出することができる。

【００４９】

ターボ（過給機）を備えたエンジンでは、当該ターボの排気タービンを迂回させるように設けたウェストゲートバルブの開度をパラメータとして加えて内部ＥＧＲ量を算出する構成としても良い。この場合、ウェストゲートバルブの開度が変わると排気圧力が変化するため、隙間容積ＥＧＲ量又は吹き戻しＥＧＲ量が変化する。具体的には、ウェストゲートバルブ開度が小さいほど、排気圧力が大きくなるため、隙間容積ＥＧＲ量又は吹き戻しＥＧＲ量が多くなると考えられる。図９には、ウェストゲートバルブ開度と吹き戻しＥＧＲ量との関係を示す。ウェストゲートバルブ開度をパラメータに加えれば隙間容積ＥＧＲ量、吹き戻しＥＧＲ量がより正確に算出でき、その結果内部ＥＧＲ量の算出精度が向上する。従って、ウェストゲートバルブの開度変更時にも筒内充填空気量Ｇｎを精度良く算出することができる。

【００５０】

上記実施の形態では、隙間容積ＥＧＲ量と吹き戻しＥＧＲ量とを各々算出した後、それらの加算により内部ＥＧＲ量を算出する構成としたが、この構成を変更し、隙間容積ＥＧＲと吹き戻しＥＧＲとを分けずに、マップ等により内部ＥＧＲ量を直接算出することも可能である。かかる場合であっても、基本充填空気量Ｇｎｂと内部ＥＧＲ量Ｇｅｇｒとを個別に算出することで、既述のとおり演算ロジックの簡素化と、筒内充填空気量Ｇｎの算出精度向上を図ることができる。基本充填空気量Ｇｎｂと内部ＥＧＲ量Ｇｅｇｒとを各々のマップデータ等を用いて個別に算出すると良い。

【００５１】

上記実施の形態では、基本的に吸気バルブ及び排気バルブの開閉時期に応じて内部ＥＧＲ量を算出する構成としたが、これを変更する。例えば、バルブリフト量を可変とする可変動弁機構を備えたエンジンにおいて、バルブリフト量をパラメータとして内部ＥＧＲ量を算出する。

【００５２】

上記実施の形態では、基本充填空気量Ｇｎｂから内部ＥＧＲ量Ｇｅｇｒを減算して筒内充填空気量Ｇｎを算出したが、これを変更しても良い。例えば、内部ＥＧＲ量Ｇｅｇｒにより補正係数を設定し（但し、補正係数＜１）、この補正係数により基本充填空気量Ｇｎｂを補正して筒内充填空気量Ｇｎを算出する。

【図面の簡単な説明】

【００５３】

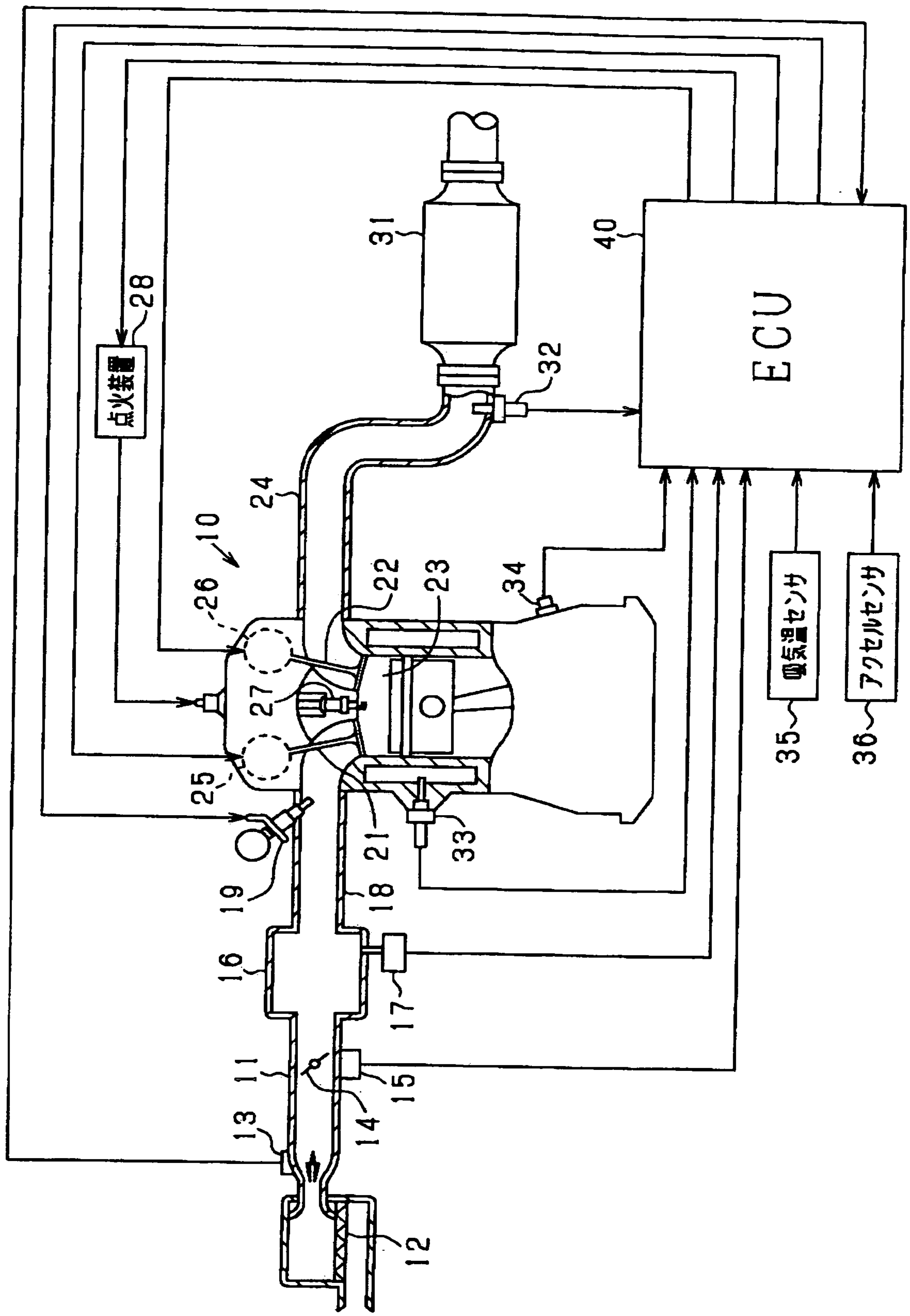
【図１】発明の実施の形態におけるエンジン制御システムの概略を示す構成図である。
【図２】吸気バルブ及び排気バルブのリフト動作を示す図である。
【図３】隙間容積ＥＧＲと吹き戻しＥＧＲを説明するための図である。
【図４】隙間容積ＥＧＲと排気バルブ閉時期との関係を示す図である。
【図５】吹き戻しＥＧＲとバルブオーバーラップ量との関係を示す図である。
【図６】筒内充填空気量の演算に関するＥＣＵの機能ブロック図である。
【図７】基本空気量を算出するための図である。
【図８】脈動補正係数を算出するための図である。
【図９】ウェストゲートバルブ開度と吹き戻しＥＧＲ量との関係を示す図である。

【符号の説明】

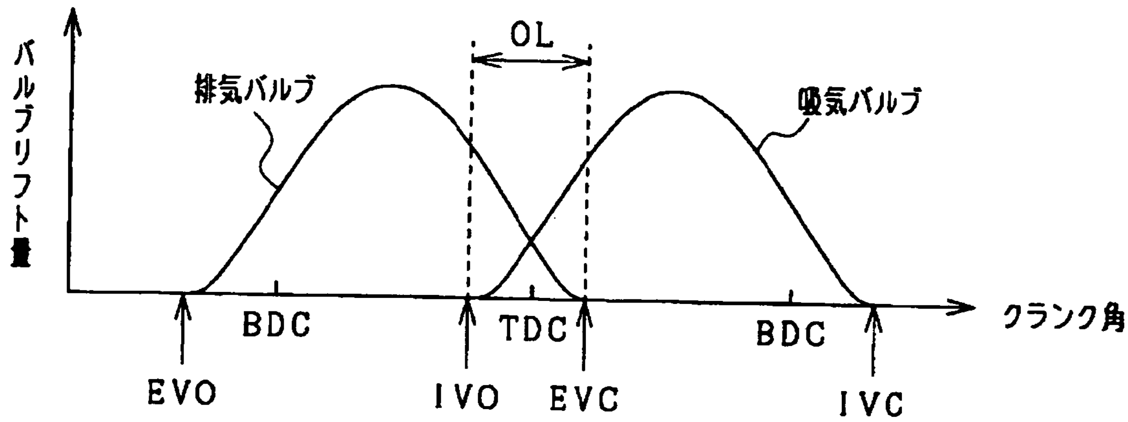
【００５４】

１０…エンジン、１１…吸気管、２１…吸気バルブ、２２…排気バルブ、２４…排気管、２５，２６…可変動弁機構、４０…ＥＣＵ。

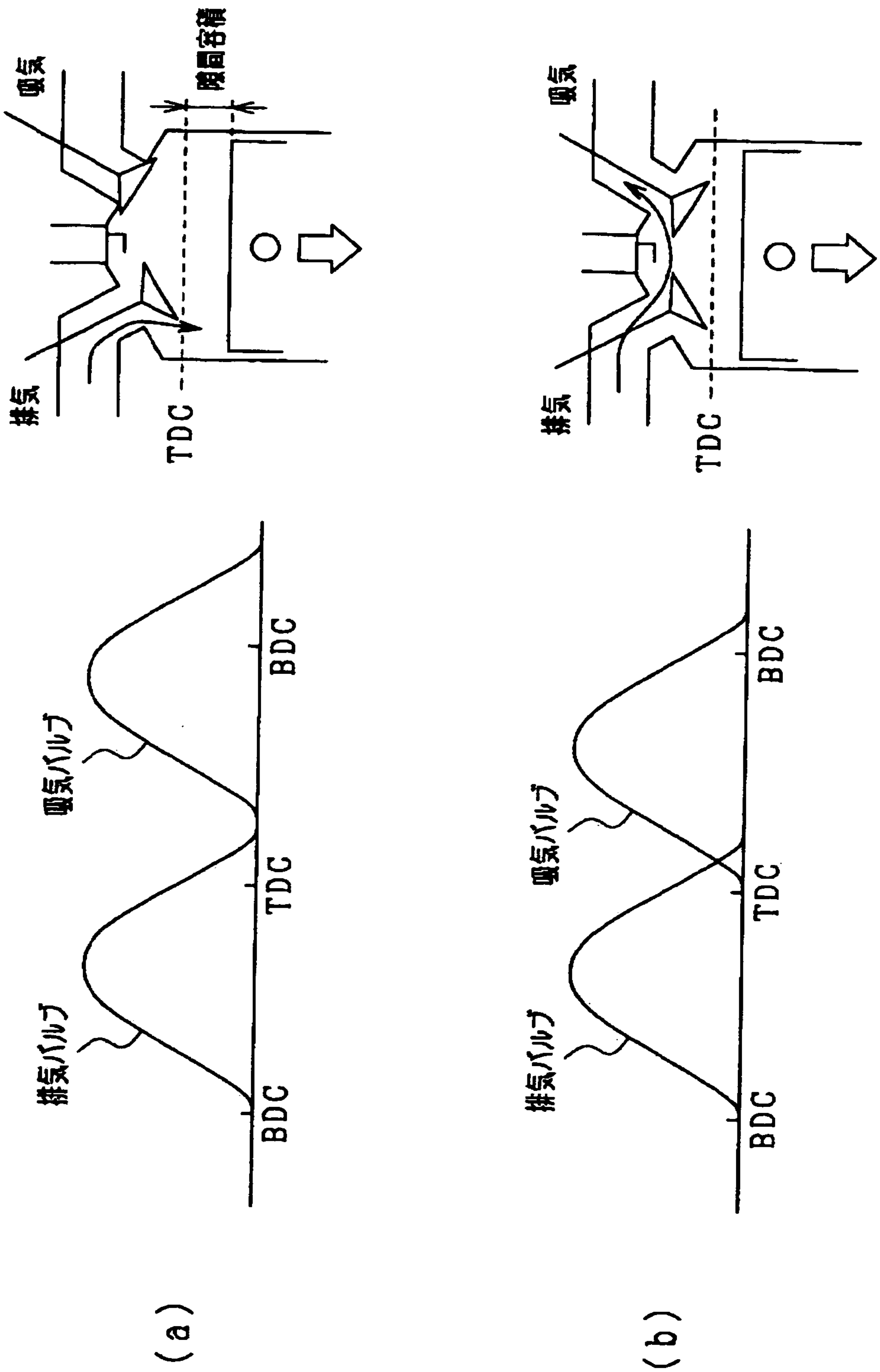
【図１】


点火装置
28
ECU
40
31
32
24
10
26
22
23
34
27
25
21
33
19
18
16
17
11
15
14
13
12
吸気温センサ
35
アクセルセンサ
36

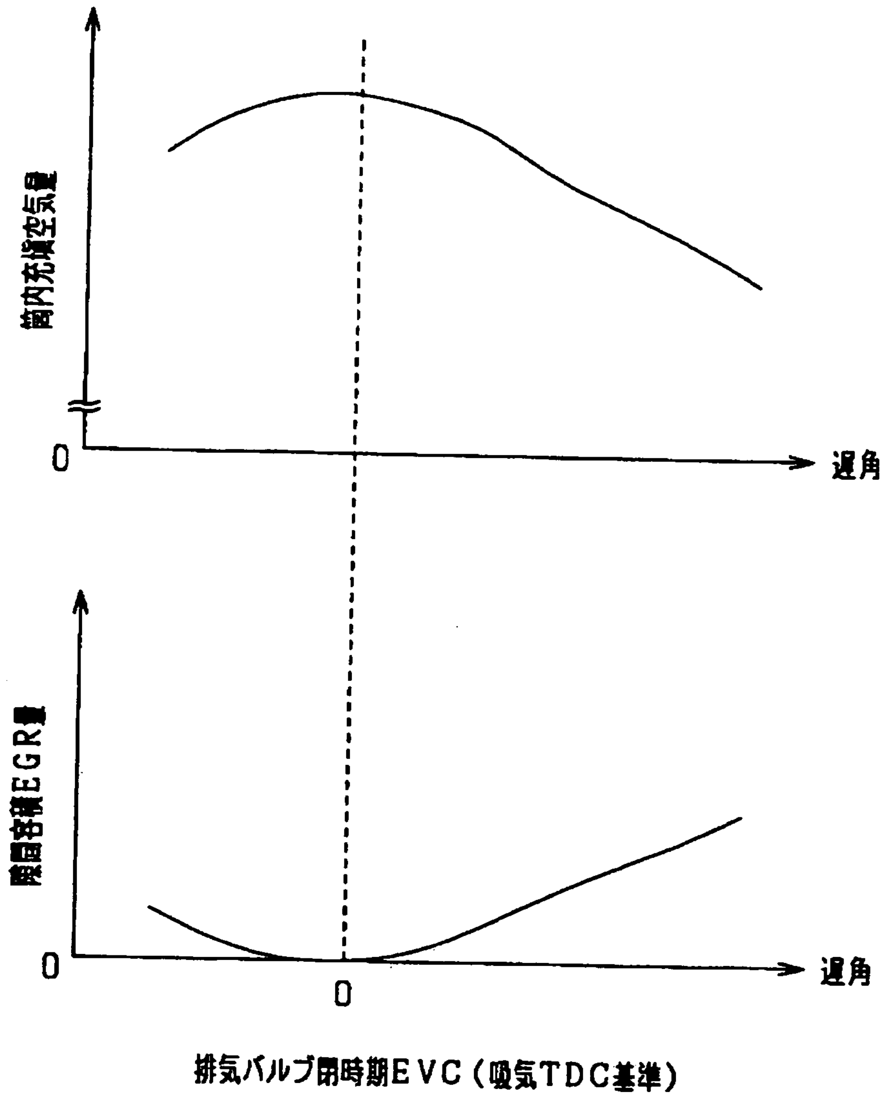
【図２】



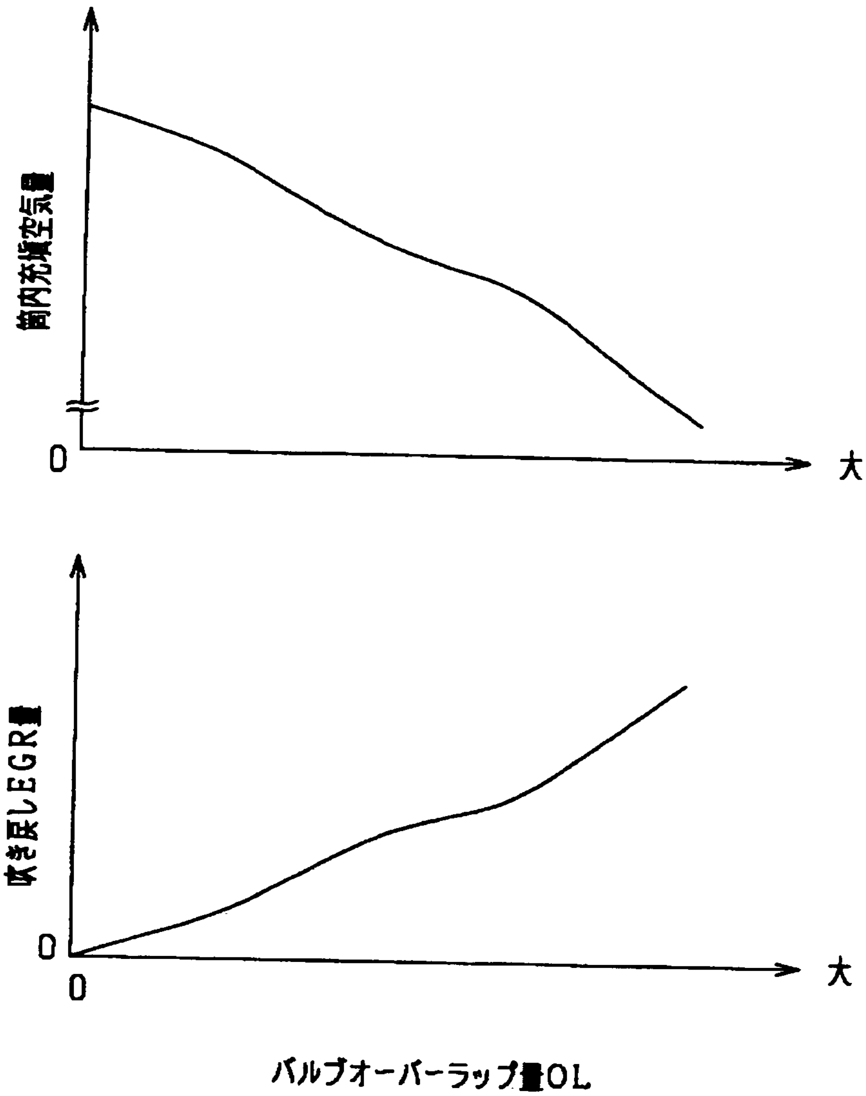
【図３】


吸気
排気
隙間容積
TDC
吸気バルブ
排気バルブ
BDC
TDC
BDC
(a)
吸気
排気
TDC
吸気バルブ
排気バルブ
BDC
TDC
BDC
(b)

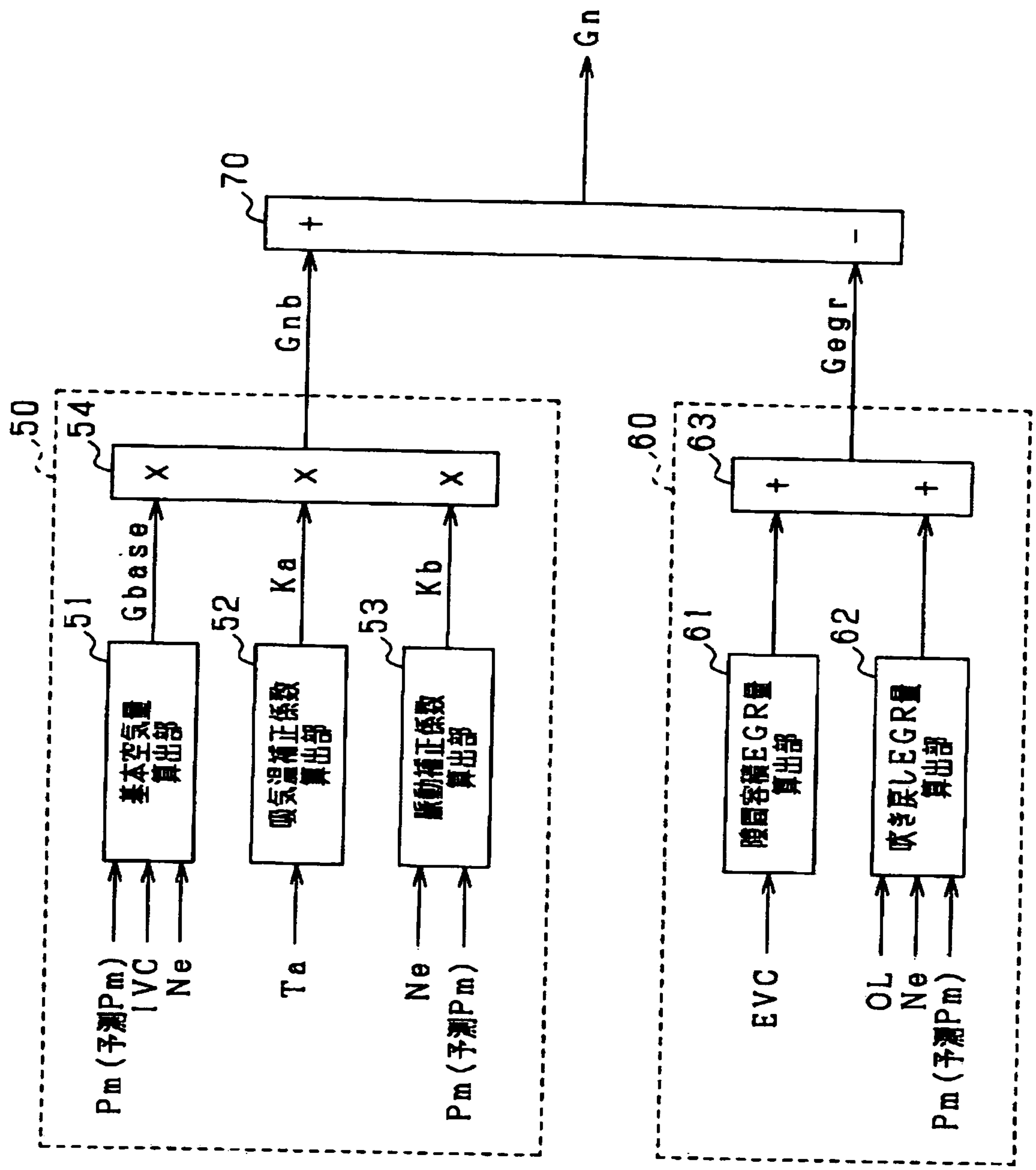
【図４】



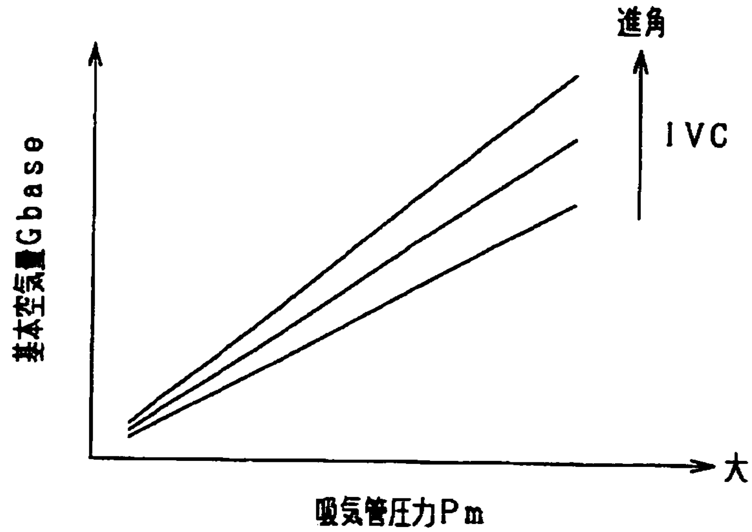
【図5】



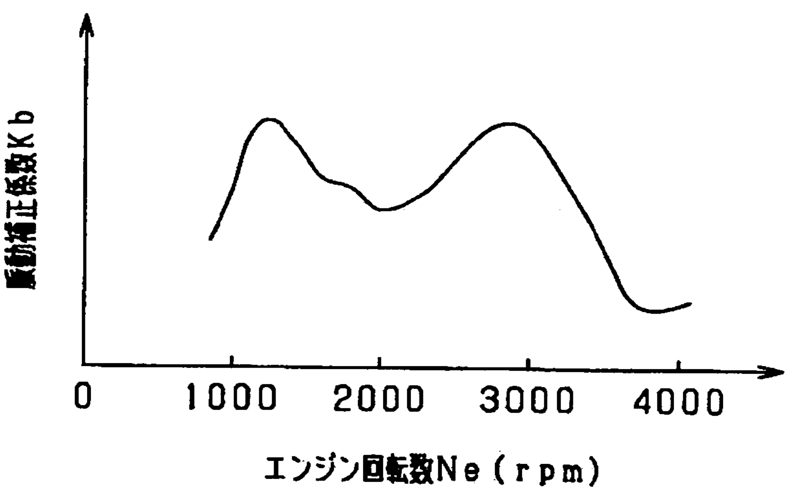
【図６】


Gn
70
+
-
Gnb
Gegr
50
54
×
×
×
Gbase
Ka
Kb
51
基本空気量算出部
52
吸気温補正係数算出部
53
脈動補正係数算出部
Pm(予測Pm)
IVC
Ne
Ta
Ne
Pm(予測Pm)
60
63
+
+
61
隙間容積EGR量算出部
62
吹き戻しEGR量算出部
EVC
OL
Ne
Pm(予測Pm)

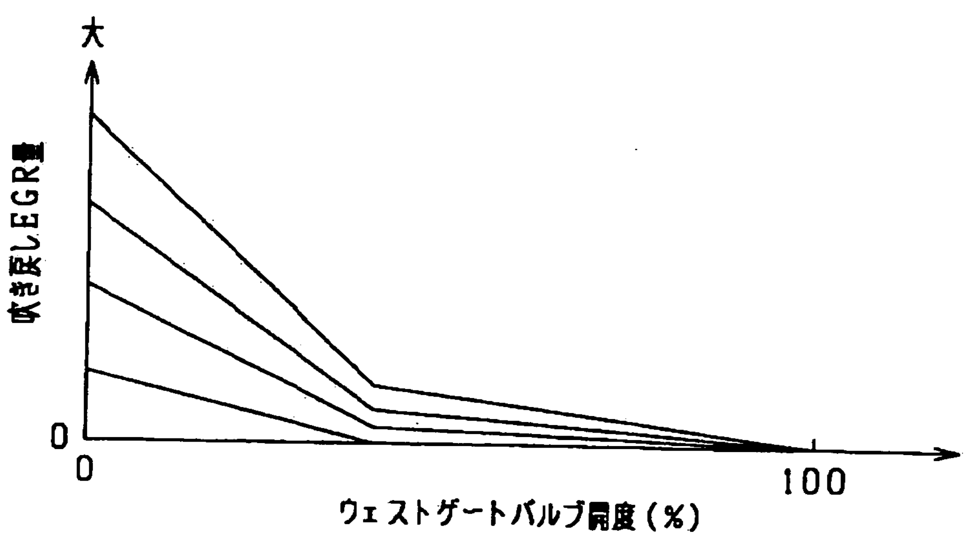
【図７】


進角
IVC
基本空気量Gbase
大
吸気管圧力Pm

【図８】


脈動補正係数Kb
0
1000
2000
3000
4000
エンジン回転数Ne（rpm）

【図９】


大
吹き戻しEGR量
0
0
100
ウェストゲートバルブ開度（%）

フロントページの続き

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